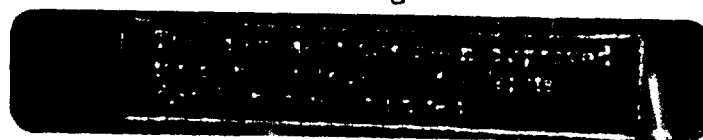SUMMARY OF

RESEARCH

ACADEMIC DEPARTMENTS

OCTOBER 1993

OFFICE OF THE ACADEMIC DEAN

UNITED STATES NAVAL ACADEMY

ANNAPOLIS, MARYLAND

SUMMARY

OF

RESEARCH

1992-1993

COMPILED AND EDITED

BY

RESEARCH OFFICE

TYPESET BY

ENSIGN JOSEPH P. IRETON, USN

ACADEMIC DEAN AND PROVOST OFFICE

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OCTOBER 1993

UNITED STATES NAVAL ACADEMY

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Foreword

T he role of research at the Naval Academy is to maintain an atmosphere of scholarly excellence in which midshipmen seek knowledge and learn through solving real problems. Discipline and curiosity are both essential to a naval officer and the balance of these traits determines the character of our graduates.

In the two decades since the Research Office was created, progress can be measured by the growth in research budgets, papers, books, and presentations. Naval Academy faculty and midshipmen have seized the opportunities to do research provided by local and nearby facilities, research courses, sabbaticals, and travel support. Direct classroom enhancement through curriculum and pedagogical development remains a constant objective.

The information presented in this report describes the research projects and productivity of our faculty and midshipmen for the 1992-1993 academic year. Each of sixteen academic departments in four divisions presents the details of its efforts. The history of the budget and productivity is presented in Figures 1 and 2, showing the growth of research by our faculty.

Three research chairs were sponsored by various Naval Commands; the total of 3.2 million dollars in research funding included 13% O&M,N funds, 66% Navy, 7% DoD, 11% federal and 3% private funds. This distribution reflects minimal institutional support and growing joint services and private funding consistent with national trends. Our major reimbursable sponsor, after the Chief of Naval Research, is Naval Surface Warfare Center whose $462K supported 25 faculty. The naval laboratories funded a record 57 faculty members' research this year for a total of $940K under the Chief of Naval Research Memorandum of Understanding. Faculty reimbursable funds increased sharply to $2204K while the total FY93 research budget continued upward to 3.2 million dollars. The faculty are moving toward active, externally sponsored research.

Midshipmen participation in research at the Naval Academy continues with ninety-nine research courses and fifty-five design courses, twelve Trident Scholars (with thirteen selected for the coming year), some 50 midshipmen using summer leave

USNA RESEARCH BUDGET
Thousands of Dollars

RESEARCH PRODUCTIVITY
Number Reported
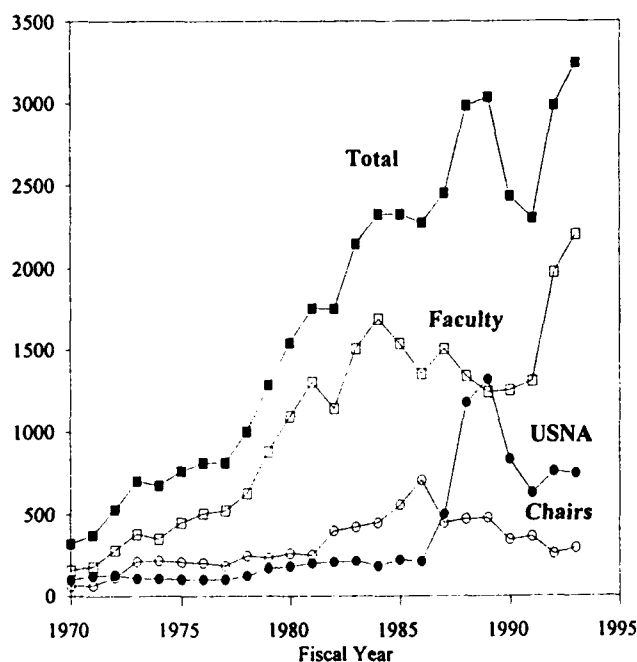
Figure 1. The growth of the research budget since 1970 reflects contributions from faculty projects, research chairs, and Academy-wide programs.
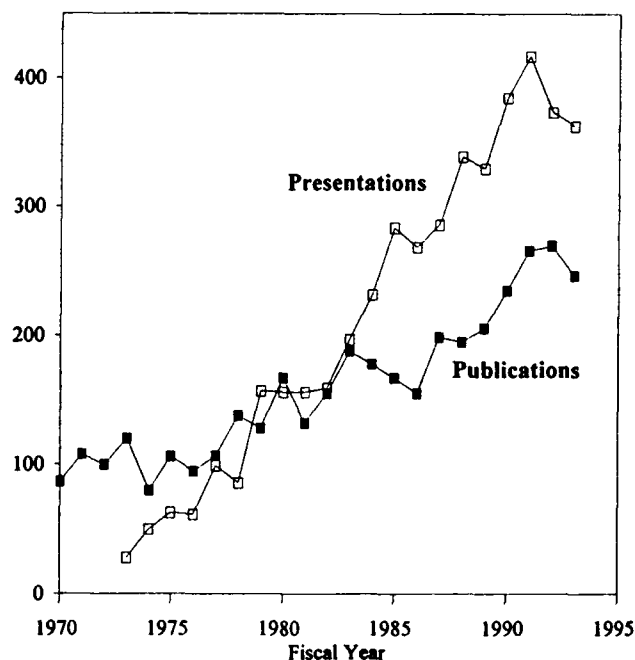
Figure 2. The productivity of faculty and midshipmen measured through publications and presentations has generally increased since 1970.

FOREWORD

time to work with a dozen Navy, DoD, and Federal Agencies, and 90 travelling abroad under the Cox foreign language program.

A Cooperative Research and Development Agreement (CRADA) was added this year with Farachem Technology, Inc. in corrosion technology, and the National Cryptological School of the National Security Agency renewed its grant in language instruction. The visiting faculty program this year included fourteen participants down from the peak of 25 in 1991. Research chairholders, Navy laboratory staff, one Office of Naval Research Postdoctoral fellow, and other individuals chose to join our faculty for a period of research. Their active dialogue with our faculty and midshipmen is an essential part of our national particpation.

Faculty research continues to be recognized nationally. Under the leadership of Professor Phyllis Culham, the Naval Academy was awarded a major grant from the National Endowment for the Humanities to support eithics in the core curriculum. Professor Robert Love and Assistant Professor Thomas Sanders won a grant from the DoD Legacy Fund to acquire copies of the Soviet Naval Archives. Major growth in faculty collaboration occurred with Naval Air Warfare Center, Warminster, and Naval Surface Warfare Center, Panama City. Eight books were published in the English, History and Mathematics Departments. Research at the Naval Academy continues to serve as both resource and catalyst for our teaching mission.

ROBERT H. SHAPIRO
Academic Dean and Provost

CARL S. SCHNEIDER
Director of Research

Contents

Division of
Engineering and Weapons

Aerospace Engineering

Professor Maido Saarlas
Chair

Professor Maido Saarlas
Chair

Faculty and midshipmen research in the Aerospace Engineering Department covers many of the areas of specialization in aerospace engineering, ranging from unmanned low-speed aircraft (RPV) to communication problems with space shuttles.

Research is supported mainly through funds from government agencies such as the National Air and Space Administration, the Naval Research Laboratory, the Naval Air Warfare Center, and the Naval Space Command. The Naval Academy Research Council provided laboratory matching funds for faculty research during the summer intersessional. This sponsored research provides benefit to its various sponsors and keeps the faculty current in state-of-the-art engineering practice. In addition, faculty participation in current development and research in the field of aerospace engineering has enhanced the learning process in the classroom, from the most fundamental courses to the final capstone design course.

Sponsored Research

Unmanned Vehicle Research

Researcher: Professor Bernard H. Carson
Sponsor: Naval Research Laboratory

This is an ongoing program in the area of unmanned vehicle research and development, now in its seventh year, in which the researcher has been actively involved. This area is distinct from other areas of UMV research in that it is characterized by extremely slow, high altitude flight, where Reynolds numbers are small and aerodynamics in this region of flight is not well understood. During the reporting period, work was conducted in the design study and development of an extremely high altitude UMV vehicle intended to fly indefinitely on solar cells.

Coaxial Propeller/Rotor Interaction Investigation

Researcher: Associate Professor Gerald F. Hall
Sponsor: National Aeronautics & Space Administration/
Ames Research Center

A computer code capable of analyzing axial inflow performance and for the evaluation of the merits of the prop-fan/tilt rotor propulsion system. This code, utilizing unsteady vortex lattice techniques, will analyze the system in hover and will also provide high speed, initially subcritical, prop-fan cruise information.

An experimental investigation, utilizing the rotor hover stand at the U.S. Naval Academy, of the prop-fan/tilt rotor system will be carried out. The full scale hover stand will provide thrust and power data as a function of vertical spacing between the rotor and prop-fan configurations, differential rotation of the two components and power ratio.

Based on the results of the analytical and experimental methods recommendations, a plan for

the development of the prop-fan/tilt rotor propulsion system will be prepared.

Theoretical Investigation of the Performance of a Wing with an Oscillatory Flap at Various Reduced Frequencies

Researcher: Associate Professor Gabriel N. Karpouzian
Sponsor: Naval Air Warfare Center and
Naval Academy Research Council (ONR)

This research proposal concerns the study of hydrodynamic performance of a high aspect-ratio wing with a trailing-edge flap oscillating at various reduced frequencies ranging from the quasi-steady limit to very high values. While the flap oscillates about a hinge line at a given reduced frequency, the wing itself is allowed to oscillate at a different frequency. The two-mode oscillation may yield an enhancement or a deterioration of the wing performance depending on the relative order of the two frequencies. Early studies on propulsion of oscillating wings without flaps demonstrate the importance of the magnitude of the reduced frequency in the performance calculation with fixed geometric and elastic parameters. They show that low-frequency oscillations exhibit high propulsive efficiency in the case of a high aspect-ratio wing. It is not known however what would the effect of trailing-edge flap oscillation be on the performance. The goal of the proposed work was then to address the problem of wing-flap performance under various oscillatory modes. The work is still in progress.

Independent Research

Exact Flutter Solution of Advanced Anisotropic Composite Cantilevered Wing Structures

Researcher: Associate Professor Gabriel N. Karpouzian

This work is concerned with flutter analysis of advancedanisotropic composite cantilevered wing structures whose structural model incorporates transverse shear deformability (TSD) and warping restraint (WR) effects. Recent work by the present author establishes the importance of these non-classical effects in the prediction of the static aeroelastic response of swept-forward composite wings constructed from transversely isotropic materials. The results reported therein show that there is an underestimation of the aerodynamic load distribution by the classical theory based on Kirchhoff's hypothesis or a moderately flexible material in transverse shear by as much as 25%. This discrepancy increases even further when the WR effects are not included. Therefore, these drastic changes cannot be ignored nor underestimated and, as a result, TSD must be incorporated for a more realistic modeling of the aeroelastic behavior of composite anisotropic structures.

The flutter analysis is carried out in the case of a uniform unswept cantilever wing under a quasi-steady two-dimensional aerodynamic load. An exact approach based on the application of the integral transform technique is employed to obtain an exact solution for the flutter eigenvalues and mode shapes. The results illustrate the importance of transverse shear deformation and warping restraint effects upon the flutter eigenvalues and mode shapes of anisotropic composite wings.

Hull-Superstructure Interaction

Researcher: Assistant Professor Michael D. A. Mackney

The principal aim of this study is to investigate the fundamental behavior of the hull-superstructure interaction from numerical and experimental studies. The numerical work uses the finite element method and three specially written preprocessors which generate data sets representing simplified models. A large number of different geometrical arrangements for both single and double superstructures have been processed. In addition a series of plane representations of the three-dimensional models have been processed. Greatly simplified beam models have been compared with both the plane and three-dimensional models. Six acrylic experimental models have been constructed, loaded, and compared with numerical models. Initial analysis shows good correlation in behaviour from the different model types, and interesting behaviours are becoming apparent from the parametric studies.

The Possible "Impossible" Turn

Researcher: Professor David F. Rogers

Investigate the feasibility of turnback from engine failure during the initial climb segment in a single engine aircraft.

Rational B-spline Curve Fitting

Researcher: Professor David F. Rogers

Investigate the feasibility of automatically fitting a rational B-spline curve to data containing a knuckle or cusp.

Research Course Projects

Methods for Deploying Collapsible Aircraft

Researcher: Midshipman 1/C Calvin W. Coates
Adviser: Professor Bernard H. Carson

The Unmanned Aircraft has been developed to a high state of the art in recent years and has its main use in low-risk surveillance of remote, hostile sites for land operations. More recently, naval interest in this concept has come forth not only as a surveillance platform, but also as a means of decoying anti-ship missiles. Such aircraft must meet more stringent requirements, however, than their land based couterparts. First, they must be able to operate at speeds approximating surface ship speeds, second, they must be stored in a collapsed state to minimize their space requirements aboard ships, where space is at a premium, and third, they must be rapidly deployable to meet an incoming threat. These requirements lead to an unmanned aircraft that will be canister launched and will erect in mid air, thence to take up its mission.

This study examined several configurations that would meet this requirement. Original plans were to construct a working wind tunnel model, but

material delays and equipment problems prevented this phase within the alloted time. It is planned for this work to be continued by another student during AY 93-94.

Coaxial Propeller/Rotor Blade Interference Investigation

Researcher: Midshipman 1/C Jeffrey W. Eggers
Adviser: Associate Professor Gerald F. Hall

The current design for NASA's VSTOL aircraft, the V-22 Ospey, incorporates two three-bladed rotors intended to provide both the vertical thrust for direct flight and the tractor propulsion for forward flight. This design is a compromise of the most efficient design for each operating regime. Yet the large radius required to provide vertical thrust limits the forward speed. One alternative design is to mount a rotor and a propeller coaxially with the rotor providing vertical thrust and the propeller providing tractor propulsion.

This investigation involves computational methods to examine the thrust and power interference of this alternative design as predicted by a vortex-lattice free-wake analysis. This method of approach is designed, by recording the coordinates of all wake filaments, to calculate the induced velocity field and to visualize the interaction between the coaxially mounted rotors. The solution is obtained numerically with an extensive code written in FORTRAN on a VAX-VMS 4000/200. Early runs with the code yielded sporadic and unpredictable thrust and power performance. A significant part of this investigation to date has involved the debugging and completion of the code. As a check to the code a method of computing the performance utilizing classical momentum theory combined with blade element theory was undertaken, calculating forces on a differential element of the blade, then integrating along the radius. The code was adapted to produce several output files which served as input files to other smaller codes designed for an analysis and estimate of the accuracy of the code. The subsidiary codes were also used to obtain time-averaged performance results and in producing graphical visualizations of the wake development and the blade-wake interaction. After an adaptation of the main code to allow for counter-rotation was completed, the code was checked against a set of similarly configured data in a Japanese report. The performance predictions obtained from this analysis were consistent with the Japanese report, and the code is now undergoing some final trial runs before it will be sent to NASA-Ames.

Remote Universal Naval Transponder (RUNT)

Researcher: Midshipmen 1/C Karl U. Schultz, Matthew D. Finney,
and James A. Pritchard, USN
Adviser: Visiting Professor James G. Severns

The RUNT was designed as a small, relatively inexpensive digital transponder which will allow quick and reliable accountability of Naval fleet assets. By utilizing the already existing Global Positioning System (GPS), a vessel can determine its position and transmit this information to the satellite which then retransmits the data to the Central Processing Terminal. The Central Terminal can then analyze, plot, and disseminate information on each vessel in its realm of control. RUNT's off-the-shelf components and simple design allow it to perform its mission dependably and at a fraction of the cost of more complex satellites.

The most important benchmark when designing the RUNT was cost. Closely related to cost was size, weight, and complexity of the system. Simplicity, compactness, and expense were all key factors when choosing all systems for the satellite.

In order to properly investigate all possible avenues of design, various subsystems were assigned to each member of the team, with one member assigned as group leader. The group leader's job was to take the information gathered by the other members and gauge which options were the most

compatible and best met the requirements of the mission. These units were then integrated into the system.

The result of this was the RUNT, a twenty-four inch diameter, fifteen-inch high, seventy-five pound satellite with body mounted solar panels. It can operate in real time transponder, or store-and-forward mode. The satellite will have 500K of memory for store-and-forward capability and an estimated lifespan of seven years. A gravity gradient boom was decided on for passive stabilization. The SCOUT missile will launch the RUNT, two at a time, into a 881 km, polar orbit.

Publications

BRAY, Robert M., Captain, USMC, "Aerodynamic Analysis of the Pioneer Unmanned Air Vehicle," AIAA-92-4635, *Proceedings* of the 1992 AIAA Atmospheric Flight Mechanics Conference, 10-12 August 1993, pp. 625-630.

Wind-tunnel tests and a numerical study were performed of the Pioneer Remotely Piloted Vehicle for static longitudinal and lateral-directional stability-and-control characteristics. Longitudinal derivatives were generally well predicted by the panel method. Directional response showed discrepancies in the determined derivatives, though rudder-with-sideslip correlated well between the two methods. Drag predictions using the panel method for inviscid drag and build-up methods for viscous drag were poor. The number of panels was insufficent to accurately model the induced drag behavior. Overall, accuracies were suitable for a personal-computer-based prediction method for preliminary design or analysis purposes.

MACKNEY, Michael D. A., Assistant Professor, "The Engineering Curricula at the United States Naval Academy," Volume 2, Innovation, Teaching and Management, *Proceedings* of the Third World Conference on Engineering Education, Portsmouth, England, September 1992, pp.27-32.

The United States Naval Academy in the Navy's college, provides eighteen majors, of which eight are in the engineering specialization. In this paper the core, cognate, and major parts of the Aerospace, Electrical, General, Marine, Mechanical, Naval Architecture, Ocean and Systems Engineering majors are discussed as a four year program preparing midshipmen for the highest responsibilities of command, citizenship, and government. Keywords: Engineering majors, Engineering Education, Service Academics, Accredited programs.

Presentations

BRAY, Robert M., Captain, USMC, "Analysis of the Pioneer Unmanned Air Vehicle," AIAA Flight Mechanics Conference, Hilton Head, South Carolina, 12 August 1992.

KARPOUZIAN, Gabriel N., Associate Professor, "Several Implication of Non-classical Effects on Flutter Response of Cantilevered Wings Composed of Advanced Composite Materials," International Forum on Aeroelasticity and Structural Dynamics,

Strasbourg, France, 24-26 May 1993.

KARPOUZIAN, Gabriel N., Associate Professor, "A Refined Structural Model of Advanced Composite Aircraft Wings and its Use in Aeroelastic Analyses," Applied Mechanics Division Summer Meeting, University of Virginia, Charlottesville, Virginia, 6-9 June 1993.

MACKNEY, Michael D. A., Assistant Professor,

"The Engineering Curricula at the United States Naval Academy," Third World Conference on Engineering Education; Session on Innovation, Teaching and Management, Portsmouth, England, 11-13 September 1992.

Satellite Ground Station Facility

Robert E. Bruninga
Director

Now in its third year, the satellite ground station was involved with a number of student and faculty projects. Routine operations consisted of providing satellite video services to various departments, conducting communications and satellite tracking laboratories for the Aerospace and Systems Engineering Departments, and tracking the space shuttle whenever it was in orbit. Hundreds of hours of foreign language programming, primarily from the SCOLA transponder (Satellite Communications for Learning), were provided to the Foreign Language Department. During space shuttle missions, the satellite dish antenna captures NASA video which often originates onboard the shuttle. This year the Naval Reserve Detachment of the Naval Space Command began performing drill weekends and active duty periods at the satellite facility. This detachment of over 20 officers and enlisted brings to the facility a cadre of experienced and well trained individuals for the continued support of experiments and operations of the facility.

Independent Research

Orbital Improvement through Doppler Tracking

Researcher: Ensign Fernando J. Argeles, USN

As a follow on to his spring semester student research project, the researcher continued to make measurements of the doppler shift of satellites during overhead passes of Annapolis. The Transit satellites, which were one of the Navy's primary satellite constillations for navigation in the 1960's and 1970's are easy to receive and have a relatively simple radio frequency carrier which is easy to measure. Most of the effort on this project during this time period was the interfacing of a GOES satellite time receiver so that precise global time was available for making the measurements.

High Altitude Balloon Tracking

Researcher: Robert E. Bruninga

This year the satellite ground station was involved in two high altitude balloon tracking evolutions. The first was tracking a telemetry package on a student built balloon launched in Connecticut. The balloon reached a maximum altitude of only 40,000 feet before radio contact was lost. The second launch was the 15 December Rocket/Balloon (ROCOON) launch from the Southeastern Community College in Whitevile, North Carolina. This payload was supposed to reach an altitude of 100,000 feet when the rocket would be separated and fired to achieve a total altitude of 300,000 feet. Unfortunately, a failure of the rocket firing mechanism prevented the rocket separation from the balloon, and the combined package was carried out to sea in the Atlantic.

Yard Patrol Craft Satellite Navigation and Communications

Researchers: Robert E. Bruninga, and Midshipmen 1/C Christopher M. Dague
and Mikel R. Huber, USN

To take advantage of the satellite navigation and communications capabilities at the Academy, a complete position reporting, tracking and communications package was developed for use on the Naval Academy boats during summer cruises. With 20 power boats and as many sail boats underway during the summer, it is important to maintain communications at all times with units at sea. The YPSATCOM system took off-the-shelf technology and for a cost of only $150 per boat was able to develop a full tactical communications and position reporting network. The position of each boat is determined by the SATNAV equipment on each of the boats. This serial data stream is transmitted approximately once every 10 minutes. On receipt at the satellite ground station, the position reports are processed and distributed throughout the Naval Academy Data Network so that officers and duty personnel can display the position and status of all units at any time. Two way messages are also supported. During the summer of 1992, a dozen boats were outfitted and by the end of the summer, the display terminals included color graphics for displaying the positions on a map of the east coast. Comparable commerical maratime satellite communications systems cost about $15,000 each.

Remote Environmental Sensing Using Satellite Data Links

Researcher: Midshipman 1/C Marcello D. Caceres, USN

Using the position and data link technology of other projects at the satellite ground station, the researcher built a remote environmental sensor system to report wind, temperature, rain and barometric pressure. His objective was a prototype sensor suitable for autonomous operation at remote sites around the Chesapeake Bay. The sites would transmit their position and weather data periodically via satellite or other VHF link to the central processing equipment at the Academy.

Navy Fleet Satellite Telemetry

Researchers: Commander Bryant Cruz, USN, Lieutenant Commander Daniel
Holeubeck, USN and Lieutenant Todd Lapin, USN

The first objective of the Naval Reserve detachment is to develop a FLEETSAT telemetry downlink capability. The researchers will demodulate and decode fleetsat telemetry and will integrate a number of software packages for display and processing of engineering data. A VAX workstation is used to run the standard Navy satellite tracking and telemetry software, COMET. Other software packages, such as RT Works will be used for developing user friendly display and control processes. Work this year has concentrated on interfacing all computers in the facility and installing appropriate networking software for processing data. The first attempts at receiving telemetry were unsuccessful, and indicated a fault in the S-band low noise amplifier.

Space Shuttle Video Uplink Experiment

Researcher: Lieutenant Commander Andrew Parker, USN (Physics)

During two shuttle missions this year, the Naval Academy satellite station was again used in an experiment to uplink live video to the shuttle. The first attempt was on mission STS-50 during June 1992. Difficulties on the shuttle with the video receiver precluded any successful video during the mission. Voice contact was successful on all scheduled overhead passes. The second mission during April 1993, again provided good voice communications with the shuttle crew, but no video recorded on the shuttle. Last year the Academy station was the first ground station ever to uplink live color video to the shuttle on mission STS-37.

Strategic Tracking of the Army/Navy Game Football

Researchers: Midshipmen 3/C John E. Roe, 4/C Trevor J. Bast, and
1/C Robert T. Howard, USN

To demonstrate the technology for using the Global Positioning Satellite System to track objects, a portable GPS receiver and VHF transmitter were assembled into a football helmet. As the 100 members of the 13th Company ran the football from Annapolis to Philadelphia on 4 December 1992, the GPS configured helmet transmitted back to the Academy the progress of the football throughout the night. Two additional GPS tracking devices were installed in the two chase vehicles manned by Midshipmen Roe and Bast. A VHF radio link delivered the position reports back to the satellite ground station where they were processed and distributed through the Naval Academy Data Network. Several large screen monitors throughout the Academy kept the brigade of midshipmen informed on the progress of the football. As part of an Electrical Engineering project, Midshipmen Dauge and Huber developed a microprocessor interface to help parse the GPS data output into a format suitable for radio transmission.

Space Shuttle Digital Communications Experiment

Researchers: Midshipmen 1/C Karl U. Schultz, James A. Pritchard
and Matthew D. Neeley, USN

The Space Shuttle Amateur Radio Experiment flew on space shuttle mission STS-47 and carried a digital robot that would reply to and log all successful contacts. On 15 September the Naval Academy was successful in making a two way data contact with the shuttle. Throughout this mission, the midshipmen predicted and tracked the space shuttle and recorded data from a number of orbits. The data included short bulletin broadcasts from the shuttle crew and lists of other stations making successful contacts. An estimated one hundred or so stations were similarly successful.

Optical Tracking System for the Naval Academy Satellite Dish

Researcher: Ensign Todd D. St. Laurent, USN

As a follow on to his spring 1992 research project, the researcher continued to refine his software for driving the 12 meter tracking antenna from signals derived from a boresight video camera. He began the conversion of his tracking software from True Basic over to a UNIX based environment. The optical tracking capability is useful during moonbounce experiments, balloon tracking and sun/moon receiver noise figure measurements. To facilitate Sun noise measurements, the boresight camera was fitted with a remote controlled and removable sun filter.

Presentations

BRUNINGA, Robert E., "Naval Academy SATCOM Packet Radio Experiments," AMSAT North America 10th Space Symposium, Intelsat Headquarters, Washington, DC, 9-11 October 1992.

BRUNINGA, Robert E., "Automatic AX.25 Position and Status Reporting," American Radio Relay League 11th Computer Networking Conference, Teaneck, New Jersey, 7 November 1992.

Electrical Engineering

Professor Richard L. Martin
Chair

R esearch and scholarly activity are fundamental to the vitality and viability of a discipline. This is particularly applicable to electrical engineering, which is broadly based and rapidly expanding. Research helps both faculty and midshipmen keep abreast of advancing technology and ultimately improves the effectiveness of the academic environment by encouraging a modern and relevant curriculum.

Funding for our research came from the Naval Research Laboratory, the Naval Surface Warfare Center, the National Science Foundation, and from within the Naval Academy. Research topics supported during the past year included Simulation of Low Dose-Rate Ionizing Radiation Testing of Microelectronics, Detection and Classification of Weld Defects in Steel Plates Using Ultrasonic Time of Flight Imaging, Detection of Undesirable Load Conditions in Motor Currents Using Discrete AM and PM Demodulation, Eye-Safe Rangefinders for Shipboard Applications, and Kemp Echo Digital Lattice Filters Incorporating Hair Cell Nonlinearities. This faculty research contributes directly to our operating forces and provides relevant topics which benefit the professional as well as the academic development of our midshipmen.

Sponsored Research

Study of the Temperature and Frequency Dependencies of the Electrical Characteristics of Metal-Oxide Ceramics

Researcher: Assistant Professor Ralph W. Bruce
Sponsor: Naval Academy Research Council (ONR)

The use of microwave energy to process materials has found widespread use in the commercial and domestic processing of foodstuffs. Of more recent origin has been the use of microwave energy for the processing of engineered plastics and ceramics. In order to adequately model the thermal and electrodynamic behavior of a material as it is being processed, knowledge of the temperature and frequency dependent characteristics of the material must be known. This interaction of a material as a load in a microwave system and that microwave system is highly dependent upon both the electrical characteristics of the microwave system and those of the material. Therefore, in order to adequately control the processes associated with microwave heating and sintering of metal-oxide ceramics, a model must be developed to test proposed metal-oxide systems and the electrical systems that will be used to perform the sintering. This proposal represents the continuation of work already performed in the determination of a foundation for a model of the temperature and frequency dependencies of the electrical characteristics of metal-oxide ceramics.

A Simulation Study of Cycloconverter Algorithms

Researcher: Assistant Professor Brian K. Butka
Sponsor: Naval Surface Warfare Center and
Naval Academy Research Council (ONR)

The Naval Ship Development Research Center is investigating two high-frequency synthesis cycloconverter algorithms. One method is based on the Venturini algorithms (Alesina and Venturini, 1981, 1989) and other on a pulse-width modulation (PWM) based technique (Neft and Schauder 1992). This work was a simulation study performed to compare the competing algorithms. The study found that the two algorithms perform very similarly and a subsequent analysis showed that the algorithms can be made equivalent under proper choices of parameters. This work derived an algorithm that is equivalent to the PWM algorithm, but does all of its calculations analytically.

Target Classification with Impulse Radar Using Higher Order Spectra and Neural Networks

Researcher: Associate Professor David S. Harding
Sponsor: Naval Command, Control and Ocean Surveillance Center and
Naval Academy Research Council (ONR)

Impulse radar involves the transmission, reflection, reception, and processing of very short pulses of electromagnetic radiation which are not sinusoidal in form. The relatively short duration of the pulses allows for a greatly improved range resolution and the potential for resolving structural detail of aircraft. Because of its very large bandwidth, impulse signal processing may be able to excite natural modes of vibration over a broader range of resonances at which a target radiates after the illuminating pulse has passed by. Detection of these resonances can be used to help identify a target. The temporal signal reflected from a target will be complex and aspect angle dependent. Therefore, advanced signal processing techniques must be applied to extract the maximum amount of information. The main objective of this project was to develop a signal processing technique to extract a set of parameters from the raw, impulse radar data suitable for use as inputs to a neural network and then to train that network to do target classification.

Simulation of Low Dose-Rate Ionizing Radiation Testing of Microelectronics

Researcher: Professor Richard L. Martin
Sponsor: Naval Research Laboratory, Code 6816

An Investigation was begun of the additional synergistic effects of elevated temperatures on CMOS devices while being irradiated by ionizing radiation. Although results have been published for CMOS devices annealed at high temperatures after high dose rate irradiation, low dose rate effects applicable to space applications have not yet been documented. Of particular interest were the effects under low dose rate conditions, but certain higher dose rates were included for comparison and to establish a reference. The experimental procedure has been applied to batches of commercial CD4007 devices from three different vendors. Preliminary results have been examined.

Detection and Classification of Weld Defects in Steel Plates
Using Ultrasonic Time of Flight Imaging

Researcher: Professors Ralph P. Santoro and Antal A. Sarkady and
Assistant Professor Don Y. Northam
Sponsor: Naval Surface Warfare Center

A Windows 3.1 based graphics workstation has been assembled to support the development of a Non-Destructive Evaluation (NDE) Knowledge Base. This workstation is built around an Intel 50 MHz 486 DX CPU and chip set and an EISA motherboard with 256K cache and 16 MB of 60 nx RAM. The graphics display subsystem used a Diamond Stealth S-3 video accelerator card and a Viewsonic 17" flat-screen color monitor. High performance storage capability is provided by a 340 MB Maxtor SCSI disk drive controlled by a 32-bit SCSI adapter with 2 MB of on-board RAM cache. Data transfer to and from the sponsor is facilitated by two MicroSolutions 80/250 MB printer port tape backup drives--one at our locations and one at the sponsor's locations. The workstations have been tested and are ready for use.

Detection of Undesirable Load Conditions in Motor Currents
Using Discrete AM and PM Demodulation

Researcher: Professor Antal A. Sarkady
Sponsor: Naval Surface Warfare Center, Carderock Division, Code 853

In an induction motor coupled to a mechanical load, shaftspeed variations produced by load defects reflect themselves as stator current variations. Consequently, abnormal current signatures can serve as a warning of dangerous motor load conditions; in some applications, such as nuclear reactors, motor current as a function of time is the only variable safely available. Because, the normal motor-current waveform is amplitude and frequency modulated (AM and FM) by the abnormal shift torque and speed variations, AM/FM demodulation techniques must be used to recover these load variations. Discrete Fourier and Hilbert transform techniques are employed to obtain the complex analytical signal representations of the AM/FM modulated current waveform. Abnormal load variations are recovered from the magnitude and phase of the analytical signal.

Eye-Safe Rangefinders for Shipboard Applications

Researcher: Lieutenant Commander Larry. T. Scalzitti, USN
Sponsor: Naval Academy Research Council (ONR)

The objective of this multi-phased project is to develop working models of systems that can be used immediately in the fleet. This project will continue work which was begun in 1988, while at the Naval Postgraduate School. The purpose is to examine various eye-safe lasers currently available for use in surface ships, adapt those laser devices to ship specific applications, and to conduct initial theoretical research and design, then procure and conduct lab and finally at-sea testing. The methods of investigation used in this research are literature search, theoretical analysis, design and implementation, procurement and fabrication, lab testing, and at-sea testing.

Kemp Echo Digital Lattice Filters Incorporating Hair Cell Nonlinearities

Researcher: Assistant Professor Louiza Sellami
Sponsor: Naval Academy Research Council (ONR)

In 1978, Dr. Kemp announced that a new auditory phenomenon, called Kemp Echo Phenomenon, has been identified in the acoustic impulse response of the human ear. These echoes were shown to be present in 98% of the healthy ears that have been tested and can be isolated with good filtering techniques. Because there is a significant difference in the Kemp echo for healthy versus certain classes of damaged ears, the researcher has developed linear models that simulate the ear in its Kemp echo response and digital signal processing techniques that lead to a systematic and noninvasive characterization of some types of damage to the inner ear. Once the type of damage is identified, the researcher hopes to design an appropriate internal hearing aid or cochlear prothesis to rectify the resulting hearing problem. Also she hopes to extend the theoretical developments of linear models of the ear to nonlinear models by introducing additional nonlinear stages such as the micromechanical and transduction stages, on one hand, and to develop appropriate *digital realization techniques for these nonlinear models, on the other* hand.

Independent Research

USNA Methods of Testing, Grading, and Instruction

Researcher: Professor Brian McDonald

During the past year as part of the exchange between BRNC Dartmouth U.K. and USNA Annapolis, I have looked at various relevant courses in both the EE and physics departments in terms of the subject material taught and the methods used for testing, grading, and instruction. Some of the information gathered will be used in improving and modifying the courses run at BRNC.

Research Course Projects

Directional Listening Enhancement Module

Researcher: Midshipman 1/C Christopher E. Novak, USN
Adviser: Lieutenant Commander John A. Koepke, USN

Patrol Squadron Ten sponsored an investigation into the enhancement of the AQA-7 Directional Listening Control Box (DLC). The objective of the investigation was to refine bearing accuracy of the DLC while maintaining real-time contact on the target of interest. A module was added to the DLC that used existing acoustic information to conduct a *signal level comparision.* The result of the comparison produced a bearing resolution 75% sharper than currently experienced by the DLC alone. Further testing is being conducted in conjunction with the Naval Test Pilot School, Patuxent River Naval Air Station, Maryland.

Autonomous Aerial Vehicle Project

Researchers: Assistant Professor Brian K. Butka, Lieutenant Commander John A. Koepke, USN, Lieutenant Commander Douglas V. P. Thoreson, CAF. Midshipmen 1/C Howard B. Link, Jr., Christopher E. Novak, and John T. Tan, USN
Adviser: Lieutenant Commander Douglas V. P. Thoreson, CAF

This is an academy sanctioned, Alumni/Corporate sponsored entry to the annual Aerial Robotics Competition. This annual competition is conducted by the Association for Unmanned Vehicle Systems, and is scheduled for every summer at Georgia Tech. The object of the competition is to individually transfer six metallic disks approximately a distance of 60 feet via an autonomous air vehicle. This project offers an excellent opportunity to integrate current Academy research and interests with many sponsored midshipman sub-projects.

Publications

BUTKA, Brian K, Assistant Professor, "The Effect of Input Voltage Harmonics on High-Frequency Synthesis Algorithm: A Simulation Study," *Proceedings* of the Summer Computer Simulation Conference, Reno, Nevada, July 1992, pp. 619 - 623.

In order to control the electric drive boats of the Navy of the future, it is necessary to generate variable frequency three-phase electrical power. This paper investigates the performance of a high-frequency synthesis = matrix converter algorithm for generating user defined voltages and frequencies. The system consists of nine electronic switches mutiplexing the three input phases to the three output phases under algorithmic control. This system is simulated on a personal computer and the effects of harmonics on the input voltages are studied. The simulation finds that even harmonics are particularly undesirable for this system since they result in D.C. components in the systems three-phase A.C. output. Methods of compensating for input voltage harmonics in the algorithm are investigated.

BUTKA, Brian K, Assistant Professor, "Device and Circuit Modeling Using Narrow-Bandgap MISFET's" *Proceedings* of the IASTED, International Conference on Modeling and Simulation, Pittsburgh, Pennsylvania, May 1993.

It is well known that the performance of infrared imaging systems utilizing narrow-bandgap semiconductors can be significantly improved by integrating the first stages of amplification on the same substrate as the detectors. The improved noise performance and reduced parasitic capacitances of such design allow weaker signals to be detected and improve the detector's response to transient signals. The MISFET is the primary element needed to perform amplifications on the same substrate as the detectors. The fabrication capabilities in narrow-bandgap semiconductors are very limited and this will severely restrict the devices available for circuit design. This analysis will examine the fabrication limitations in these materials and what devices are available for circuit designs fabricated in narrow-bandgap semiconductors.

This analysis will survey the available narrow-bandgap MISFETS models and the suitability of each model to circuit design usage. Using these models, the performance of the prototype circuits will be studied and the potential for more complex circuits in this technology will be examined.

LIM, Tian S., Associate Professor, "Parallel Communication With Handshake Between Two Microcomputers," *Proceedings* of the 1993 IEEE SOUTHEASTCON, April 1993 pp. T2A 4-1 to 4-7.

This paper describes a straight forward implementation of the full asynchronous interface between two microcomputers. It details the design and test of a two-way, one line message display arrangement between two machines. The arrangement allows the user to send a message

from the transmitting machine to the receiving machine and the message will appear simultaneously at the screens of both the transmitting and receiving machines. The two-way arrangement allows each of the two machines to be able to send and to receive a message. Eight data lines are connected between the input and output ports of the two microcomputers. The message is sent and received via the eight parallel data lines with the help of data ready and data taken handshake lines.

KOEPKE, John A, Lieutenant Commander, USN, "Hang Standoff Weapons on the P3," USNI *Proceedings*, January 1993, pp. 83-84.

The article addresses the limited utilization of the U.S. Navy's Maritime Patrol Aircraft in combat roles. An expanded weapons inventory would enhance the effectiveness of the P3 as an offensive platform. Warfare Commanders could realize a highly mobile cruise missile launch platform or a front line interdiction attack aircraft. Armed with such flexibility, the Warfare Commander would greatly complicate an advisory's defensive planning.

Presentations

BRUCE, Ralph W., Assistant Professor, "The Use of Microwave Energy in the Production of Engineered Ceramics," Institute of Electrical and Electronic Engineers, Annapolis Subsection Meeting, Annapolis, Maryland, 7 May 1992.

BUTKA, Brian K., Assistant Professor, "The Effect of Input Voltage Harmonics on A High-Frequency Synthesis Algorithm A Simulation Study," 1992 Summer Simulations Conference, Reno, Nevada, 27-30 July 1992.

BUTKA, Brian K. Assistant Professor, "Device and Circuit Modeling Using Narrow-Bandgap MISFET's," IASTED International Conference on Modeling and Simulation in Pittsburgh, Pennsylvania, 29-30 April 1992.

Mechanical Engineering

Professor John O. Geremia
Chair

Research in the Mechanical Engineering Department encompasses several areas of specialization within the braod field of mechanical engineering. These areas included internal combustion engines, fluid dynamics, mechanical and thermal design, and materials science. Specific objectives of the current research varied from computer modeling of centrifugal pumps to the development of advanced composites and ceramic materials research. Research was supported by a variety of sponsors, including the Office of Naval Research, the Nuclear Regulatory Commision, the Naval Surface Warfare Center, and the Naval Academy Research Council. In addition, some faculty pursued independent research in areas of personal interest.

Research efforts at the Naval Academy are driven by the need for faculty to stay abreast of rapidly changing technology and subsequently to introduce that new technology into their courses. Some updating of course material is also facilitated by seminar speakers and visiting professors. The efforts of the mechancal engineering faculty to become more effective classroom teachers through their research activities are reflected by their numerous publications and presentations at national and international conferences.

Sponsored Research

Evaluation of the Impact of Decentralized Cooling Systems on Future Submarines

Researcher: Associate Professor Elliott E. Dodson
Sponsor: Naval Surface Warfare Center, Annapolis Laboratory

The future availability of chlorinated fluorocarbon refrigerants for use in naval chilled-water plants is threatened by environmental concerns. Thermoelectric cooling is an alternative that was evaluated for SSN 21 in 1984 by the Electric Boat Division of General Dynamics Corporation. The process was found to be heavier and less efficient than vapor compression cooling.

The data used in the Electric Boat study was modified by David Taylor Research Center to include technological advancements in design and thermoelectric material performance; the results are presented in this report. Modification involved the entire heating, ventilating, and air conditioning system (with evaluations of several optional configurations) and the waste heat rejection system.

A decentralized heating, ventilating, and air conditioning system with an environmentally acceptable cooling system, combined with decentralized passive through-the-hull cooling panels, showed potential reductions of 200,000 lb and 2,500 ft^3, and no increase in power. Changing to a decentralized system would reduce the weight for distribution in centralized systems. Decentralized cooling would reduce submarine cost due to modular construction and because a major portion of ventilation ducting would be eliminated. The decentralized system would also provide increased survivability, arrangement flexibility, and reduction of the acoustic signature.

Recommendations for future work required to overcome major obstacles and to demonstrate the advantage of decentralized cooling are presented.

For the period of 16 June 1992 to 15 August 1993 work was extended in order to examine ventiliation system cost data, and its impact on alternative HVAC system configurations for SSN 21.

USNA/CSS Fin/Hull Investigations

Researcher: Professor Joseph D. Gillerlain, Jr.
Sponsor: Coastal Systems Station, Panama City, Florida and
Naval Academy Research Council (ONR)

The accurate prediction of the hydrodynamic characteristics of submersible vehicles is an important part of the design process. Reliable predictive methods for fin-hull interference effects can save both time and money in the fabrication and testing of both models and prototypes. Whereas extensive data are available for submarine and torpedo configurations, there is very little information on hull geometries similar to those of swimmer delivery vehicles. The objective of this investigation is to characterize the fin-hull interference for a series of axisymmetric hull shapes with varying fullness fitted with flat-plate fins of varying chord and span. The resulting data will be compiled with existing data for submarine and torpedo configurations to help develop semi-empirical methods for the prediction of hydrodynamic forces and moments for a wider range of hull geometries. Hull shapes with several different afterbody slopes and a complete set of fins have been fabricated. Data have been obtained for two of the hull shapes. Further tests are in progress. Data reduction and analysis is continuing.

The Effect of Environment on the Mechanical Composite Materials

Researcher: Professor Dennis F. Hasson
Sponsor: Office of Naval Research

Future Naval structural and power systems applications require advanced engineered materials. Composites with matrices from the three material classes (e.g. polymers (PMC), metals (MMC) and ceramics (CMC)) have many of the desired mechanical characteristics. The effect of unusual environments have not been widely studied (e.g. for PMC's, high pressure seater soaking followed by freeze/thaw cycles; for MMC's, creep; and for CMC's, high temperature impact toughness).
Continuation of the studies above on PMC's, MMC's, and CMC's will continue. Short beam shear tests will be performed on the freeze/thaw cycled PMC's. SEM fractography will be performed to determine the extent and nature of F/T damage. Creep tests will be initiated on the in situ MMC material. Residual strength and high temperature impact will be done on CMC materials. In order to achieve improved fracture toughness, emphasis will be to obtain a better understanding of the causes and nature of fracture in composite materials.

Constraint Effects on Elastic Plastic Fracture

Researcher: Professor James A. Joyce
Sponsor: U.S. Nuclear Regulatory Commission

This is a new effort for USNRC to develop a correction methodology to relate small scale surveillance specimens to large structural applications, like the nuclear reactor constraint vessel. Analytical and numerical work is being sponsored at the University of Illinois and Brown University and experiment work is being done at the Naval Surface Warfare Center and the U.S. Naval Academy. Tests are being conducted on a range of geometries and specimen sizes and the new Q parameter is being utilized to relate the small specimens to the large specimen results. Both transitional and upper shelf testing and analyses are being conducted.

Influence of Heat Treatment on the Corrosion Properties of Stainless Aluminum Alloys

Researchers: Mr. Walter S. Laird, Dr. Christopher Streinz (Postdoc),
and Mr. John Hein
Sponsor: Office of Naval Research

Aluminum alloys are used extensively in the United States Navy and range from light weight, high strength aircraft components to super structures on ships. Corrosion problems are commonly encountered with these materials. The elements typically added to aluminum to improve mechanical properties such as copper, magnesium, and zinc, generally do not increase the corrosion resistance. However, a new class of aluminum alloys with exceptional corrosion resistance, referred to as "stainless aluminum alloys," have been developed by the Naval Research Laboratory. These materials involve alloying elements which specifically increase the aluminum alloy's ability to resist corrosion; such as tantalum, tungsten, silicon, molybdenum, and chromium. These elements help to form a more protective passive film on the aluminum surface which dramatically improves the corrosion resistance. Unfortunately, these elements have limited solubility in the aluminum crystal structure and if they are processed by conventional means or if they are heated after processing, additional phases develop and the alloying element will no longer be in the aluminum matrix and will therefore not develop the enhanced corrosion resistance. Therefore, these materials must be processed by fast solidification methods which trap the alloying element in the parent aluminum phase. This project is evaluating two rapid solidification processing methods, spray forming and sputter deposition, for the production of these alloys and is evaluating the influence of subsequent heat treatment on their corrosion properties. Aluminum-tungsten and aluminum-molybdenum alloys are being investigated because these two alloys have shown good corrosion resistance and some resistance to development of second phases during heat treatment.

Development of a Remote Sensor for the Detection of Crevice Corrosion

Researchers: Associate Professor Patrick J. Moran, and Mr. John Hein
Sponsor: Office of Naval Research

Farachem Technology, Inc. is a small business located in Ohio. This company has a Small Business Innovative Research Grant from ONR to develop remote sensors for the detection of crevice corrosion in seawater piping systems. The researcher has expertise in crevice corrosion mechanisms and in magnetic detection of corrosion currents. Through the ONR contract the researcher is assisting Farachem Technology, Inc. in the design and development of remote sensors for crevice corrosion based on detecting the small magnetic fields generated by the crevice corrosion currents.

Investigation of the Crevice Corrosion of Alloy 625 in Seawater

Researchers: Associate Professor Patrick J. Moran, and Mr. John Hein
Sponsor: Naval Academy Research Council (ONR)

Alloy 625 is a NiCrMoFe alloy and is the main piping material in the new SSN21s. Alloy 625 has excellent mechanical and welding properties and, with the exception of crevice corrosion, excellent

corrosion properties. It has been found to be susceptible to crevice corrosion in seawater service. NSWC-Annapolis is the main Navy laboratory evaluating the problem. Crevice corrosion occurs because acidic environments develop in crevices due to hydrolysis of the metal corrosion products (cations) which concentrate in the restricted crevice. One of the difficulties in modeling crevice corrosion processes or in proposing solutions is that it is not known in what proportion the Ni, Cr, Mo, and Fe dissolve from the Alloy 625 surface in the crevice environment. These elements control the extent of acidity. In this research project specimens which have experienced crevice corrosion are being carefully analyzed with scanning electron microscopy and x-ray microanalysis to determine the concentration of the Ni, Cr, Mo, and Fe remaining at the attacked sites. Specimens with varying amounts of crevice corrosion attack were obtained from NSWC-Annapolis. Comparison of the concentrations of the attacked regions with the normal alloy concentration is allowing determination of exactly what elements dissolved into the crevice region and promoted the aggressive environment. Such information will lead to better modeling of the crevice corrosion process for Alloy 625 which will allow the severity of attack in various crevice geometries to be predicted accurately and will assist efforts to develop control measures and alternative materials. Upon completion of this analysis the author plans to approach a commercial alloy producer to produce test heats of alloys with similar concentrations of alloy 625 but with modifications intended to reduce the crevice corrosion. Evaluation of the modified alloys will be conducted in laboratory tests at United States Naval Academy.

Bifurcations and Chaos in Nonlinear Dynamical Systems: Applications to Composites

Researcher: Assistant Professor Raouf A. Raouf
Sponsor: Naval Academy Research Council (ONR)

It is known that engineering structures, including composites, experience a variety of common nonlinear dynamical phenomena. This behavior is captured by the nonlinear equations of motion which are usually reduced to nonlinear ordinary differential equations. An understanding of these nonlinear equations is the first step in understanding the complex dynamics of the physical structures. For a specific structure, however, many factors affect its linear and nonlinear dynamic response. In the case of composites, these factors include manufacturing processes, residual stresses, fiber orientation, thickness, and other material and geometric properties. Knowing the effect of these parameters on the behavior of composites gives the designer the ability to meet specific design requirements in the most efficient way.

This research uses a combination of computational and analytical techniques to study the nonlinear response of dynamical systems in general composite panels in particular. Combined symbolic-numerical algorithms are used to detect various types of bifurcations and to study the nonlinear dynamics of curved composite panels.

Influence of Implanted Nitrogen on the Corrosion Properties of Stainless Steel Alloys

Researchers: Dr. Christopher Streinz and Mr. John Hein
Sponsor: Office of Naval Research

Nitrogen additions to stainless steel improve the corrosion resistance of stainless steel in chloride environments. A novel process for implanting nitrogen in stainless steel has been developed at NIST. The process achieves higher concentrations of nitrogen in the stainless steel than are possible with traditional processing. The corrosion properties of these new materials are being evaluated at United States Naval Academy and compared to conventional stainless steels. The

integrity of the passive film, the resistance of pitting corrosion and crevice corrosion are being evaluated. Results to date indicate that the corrosion properties of the novel stainless steels are superior to conventional stainless steels of the same composition (ignoring the nitrogen added).

Independent Research

Hybrid Electric Vehicle Battery Pack Cooling

Researchers: Assistant Professor Gregory W. Davis and
Assistant Professor Steven M. Miner

Hybrid Electric Vehicle (HEV) competition regulations require that the battery pack be vented during charging to prevent a build-up of hydrogen. However, an equally important concern is the operating temperature of the batteries during the charging process. Excessive temperatures can lead to a reduction in the life of the batteries, and increased operating costs for the HEV. This study uses Computational Fluid Dynamics (CFD) to analyze the cooling of the battery pack in the Naval Academy HEV. The cooling passages in the battery pack are modeled to determine the air velocity, pressure and temperature in the individual passages, as well as, the surface temperature of the batteries themselves. The results of the study will be used in an effort to optimize the design of the battery pack cooling, which includes passage sizing and placement, fan selection, and cooling sensor location. A paper detailing the results will be prepared for the SAE World Congress.

Elliptic Vortex Dynamics

Researcher: Professor Robert A. Granger

The two-dimensional problem of the motion of a vortex of constant intensity in a simply connected region of an unbounded ideal incompressible fluid was considered by Rankine, Kirchoff, Love, Chaplygin, and Granger.

Rankine found the simplest exact solution: a circular vortex, or what is called solid-body rotation followed by a free-vortex. Kirchoff obtained an exact solution to the problem of uniform rotation of an elliptic vortex in a fluid at rest at infinity. Love considered the stability of this solution by linearizing the equations of the disturbed motion. He showed that if the ratio of the lengths of the axes of the ellipse satisfies $\chi > 3$ the motion is unstable with respect to the third perturbation mode of the elliptic boundary. Chaplygin, who considered the problems of whirlpools in rivers, found a more general solution with rotation and pulsation of an elliptic vortex in a shear flow. Exact steady motions of an elliptic vortex in a flow that is linear with respect to the coordinates are few to find in the literature.

Because of the intensive investigation of the vortex action in oceans, much attention is presently paid to large scale phenomena, such as the Gulf Stream rings. In studying this case, a hydrodynamic mathematical model is proposed in the form of a vortex of constant vorticity. The problem is reduced somewhat to a solution of infinite collection of ordinary differential equations. An approximate solution is investigated.

We consider the general dynamical equations that take into account the displacement of the center of the ellipse. A new one-parameter series of steady motions of an elliptic vortex is obtained. The ellipse rotates about its center as a rigid body with constant angular velocity, while the center of the ellipse rotates in a circular orbit having the same angular velocity. The major axis of the ellipse is

directed towards the center of the circular orbit. The condition of continuity of the pressure on the ellipse's boundary is satisfied approximately.

Experiments in Heat Transfer and Thermodynamics

Researcher: Professor Robert A. Granger

Students learn by doing, perhaps engineering students especially, and they will better understand the principles of heat transfer and thermodynamics by conducting experiments and seeing results.

This book is a collection of experiments in heat transfer and thermodynamics contributed by leading engineering educators. The experiments have been tested, evaluated, and proved successful for classroom use.

Each experiment follows the same step-by-step format which includes the objective of the experiment, apparatus needed, procedure, suggested headings, and references. The experiments use apparatus that is easily built or attainable.

Among the topics covered are heat conduction, convection, boiling, mixing, diffusion, radiation, heat pipes and exchangers, and thermodynamics.

The book will be especially useful as a companion to standard heat transfer and thermodynamics texts.

Chaos of Surface Waves in a Cylindrical Tank

Researcher: Professor Robert A. Granger

New types of forced and parameter vibrations of the fluid surface in a cylindrical tank due to interaction with the excitation mechanism of a limited power-supply (so-called "limited excitation" phenomena) are investigated in detail. On the basis of analysis of the largest Lyapunov exponents for a complex system - a tank with fluid and an excitation arrangement - the regions are determined for four steady-state regimes: stationary, periodic, almost-periodic and chaotic. Attention is concentrated mainly on the properties of chaotic attractors and schemes of transition from "order" to chaos. It is established that different scenarios of transition to chaos and various structures of chaotic attractors are possible in the same physical system. It is shown that some steady-state chaotic regimes can originate only due to interaction with the excitation mechanism.

In view of its practical importance, the possible modes of vibration of the free surface of a fluid in a rigid container have been studied intensively from different points of view. The revolution in our understanding of the physics of the phenomenon brought by the discovery of chaotic types of motion in deterministic systems has forced re-evaluation of previous results, in particular, the details of chaotic types of motion in certain physical systems. In addition, the discovery of chaos has changed the methodology used to study these problems, it has broken down earlier stereotypes, and has led to the rejection of certain unfounded assumptions, such as the method of reduction, which states that the behavior of a complicated system can be determined by the properties of its components sub-systems.

The new point of view is that the dynamics of a complicated system depends more on the coupling between the sub-systems than on the sub-systems themselves. For example, in cases where certain normal modes of vibration of a distributed system are coupled and have the same frequency (as in the case of excitation of degenerate modes), regular steady-state vibrations of any of the modes will "deteriorate" into chaotic motion because of the nonlinear interaction between them (Miles 1984, Meron & Procaccia 1986, Crawford & Knobloch 1991). In the case of closely similar eigenfrequencies in modes with different wave parameters, their interaction also gives birth to chaos (Ciliberto & Gollub 1985, Umeki & Kambe 1989, Kambe & Umeki 1990, Miles & Henderson 1990).

Another example of such coupling is the interaction of a vibrating system with an excitation mechanism. This interaction is always present because of law of conservation of energy. When the vibrating system possesses damping (actually

damping is present in all real systems), the dissipation of the energy of the excitation mechanism could introduce essential corrections into the regimes of mechanism functioning. In this way, the vibrating system influences the parameters of the excitation force. This influence is considered significant when the power of the excitation mechanism is comparable to the power dissipated in the vibrating system. In this case the vibrating system has a limited excitation and the mechanism has a limited power-supply (Kononenko 1969). This situation is considered in the present study. The limited excitation phenomena was first studied by Sommerfield (1904) and Timoshenko (1928). In these studies attention was focused on the changes of electric motor working regime, and not on the vibrating system. As shown by Kononenko (1969) for a linear oscillator with limited excitation the characteristics of a linear oscillator arise, such as the occurrence of instability regions. In view of this, in the present study, the existence of new possible characteristics is investigated for forced and parametric resonant vibrations of the fluid in tanks, which result from the interaction of the vibrating system with the energy source - the electric motor.

As a result of investigating the nonlinear process of interaction between the tank filled with fluid and the motor with limited power-supply the following conclusions can be drawn: (1) The resonant vibrations of a fluid free surface can be described by six-parametric systems of equations of the fifth order. Those systems are low-dimensional models ((18), (31)) which contain all the essential features of each type of resonant vibrations (forced or parametric); (2) The existence of several types of chaotic attractors was established for described systems. It was shown that the transition from regular to chaotic motion may occur with different scenarios such as: cascade of period-doubling bifurcations, intermittency, and rigid transition; (3) It was shown that the chaotic steady regimes are typical attractors for the described systems. In the parameters space, large regions were found where chaotic motions exist. In the phase space, the regions were localized where the chaotic attractor was the only attractor of the system; and (4) It was established for averaged systems that chaos could originate only from the process of interaction of a directly excited resonance mode of vibrations with the electromotor during forced resonance, when a second dominant mode was not excited altogether. One-mode chaotic regimes could not occur in the case of an ideal excitation as well as two-mode chaotic regimes for parametric resonance.

Jet Discharge Into a Cavity

Researcher: Professor Robert A. Granger

An exact hydraulic analysis of an axisymmetric jet discharging into a closed cavity has been theoretically treated. The only requirement is that the radial distribution of the axial velocity at the base be known.

In the present mining technology, one frequently observes the use of liquids and gases to break up rock formations. The technique usually involves submerged hydraulic jets impacting on stratum of rocks. Other methods might incorporate introduction of particulates, such as sand, in the gas or liquid stream.

Questions have arisen in the literature on the hydraulics of an axisymmetric jet discharging into a closed cavity, in particular what the distribution of both radial and axial velocity components will be.

Some Experimental Observations of Secondary Motions in a Confined Vortex Flow

Researcher: Professor Robert A. Granger

Three decades have passed since vortex breakdown was first identified as a natural phenomenon. Three key theories have been proposed to explain the phenomenon: hydrodynamic instability, conjugate states and flow stagnation. Despite a considerable amount of theoretical and experimental investigation, there is still nothing approaching a completely satisfactory theory of vortex breakdown.

In addition, there is no agreement on a complete physical description of the structure of vortex breakdown. The present experimental investigation may substantiate a few earlier conjectures. We discuss an experimental finding that might help clarify the phenomenon through the use of flow visualization and laser-Doppler velocimetry. Experimental measurements substantiate earlier measurements and theoretical calculations of the velocity field. The evidence suggests that there is a connection between criticality and instability.

This paper briefly presents the results of a simple experiment that was made to investigate the fundamental nature of secondary motions in a confined vortex. It is the opinion of the author that the phenomena observed have considerable implications. Examining the secondary motions suggested certain conclusions that may prove a key to understanding the nature of breakdown in confined vortex flows. It should be pointed out that the pursuit of examining the velocity field after vortex breakdown led to the accidental discovery of secondary motions.

A resume of the findings is the following: (1) The breakdown can be a solitary spherical disturbance with laminar flow upstream and downstream, or a bubble-like disturbance, or a spiral-type disturbance with a turbulent wake consisting of at least two helical vortex filaments; (2) The vortex breakdown is confined approximately to the core and its size is inversely proportional to Γ_{ω}; (3) Vortex breakdown is observed to be largely an instability problem since the flow degenerates into an unsteady motion in the turbulent shear layer where the initial perturbation grows unchecked; (4) Observations are made on a vortex whose dimensionless circulation is proportional to the dimensionless stream function, the constant of proportionality being the square root of the Rossby number; and (5) New regions of secondary motions are identified in the irrotational region of an otherwise steady vortex flow, motions that have as yet no theoretical basis.

Owing to the elusive nature of the secondary motions in the irrotational region, more decisive testing is very difficult. Thus, conclusion (5) is at best poorly defined. In fact, it is not truly a finding but a prescribed property of the flow field. Conclusion (4) is substantiated by Granger's theoretical anaysis (1972, 1973). The merits of this experiment have been in helping to identify the breakdown as principally an instability problem rather than one of critical states; and in demonstrating that a turbulent shear layer exists in internal vortex sink flows with large-scale asymmetric vortices and higher-order secondary motions in a field far removed from the core even though a normal vortex had been restored in the core.

Investigation of a Line Array of Cylinders in Towed and Free-Descent

Researcher: Professor Robert A. Granger

For decades, the Navy has needed a way to clear surf-zone mines. This was substantiated during Desert Storm Operations, when concerns about mine threats had a serious impact on planning a possible Marine amphibious assault on Iraqi forces in Kuwait. Recent naval studies have concluded that brute force explosives represent the only viable means of clearing surf zone and craft landing zone mines. The recently emergent distributed explosives technologies (nets and improved line charge arrays) offer the optimum combination of system volume, weight, and effectiveness.

The Explosive Neutralization Program will demonstrate the capability to explosively neutralize anti-invasion mines in the surf zone and craft landing zone. An explosive system (net or line charge) will be launched from a seaborne platform such as a Landing Craft Air Cushion (LCAC) or an Army Pontoon Air Cushion Kit vehicle. Multiple launchings will be required to cle r lanes that are sufficiently wide for the landing force.

The Coastal Systems Station (CSS) is responsible for the line-charge design. A line-charge is a series of warheads encased in cylindrical shells and separated by a fixed distance along a detonation cord and a load-bearing rope. Accurate deployment of multiple line-charge arrays requires an understanding of the aerodynamic loads on the array during its ballistic trajectory and the hydrodynamic loads during water impact and descent to the bottom. To assist in the design effort, CSS has contracted with the U.S. Naval Academy to perform analytical and experimental studies on candidate arrays. The experimental

program will be performed in the Academy's 385-foot towing basin. Full-scale models will be tested to determine their in-water descent and aero/hydro drag properties. The analytical effort will explore the development of a simple model to predict the descent of a line-charge through the water column.

The objective of the research project is to characterize the aerodynamic and hydrodynamic loads on candidate line-charge arrays through experimental and analytical studies. This information is needed to design a fire-control system to enable the accurate deployment and alignment of multiple array in the surf zone and craft landing zone.

The experimental program will be conducted in four tasks. The first is pre-test preparations involving fabrication of the models, modifications to the test facility to accommodate the models, and the preparation of a test plan. The second task will investigate the free-fall descent of candidate arrays in varying the shear states. The third task will measure total drag forces on arrays towed at several speeds through the basin. The final task will document the results of the test program.

Fluid Dynamic Behavior of a Hot Vertical Plate in Unsteady Viscous Flow of an Incompressible Fluid with Variable Suction and in a Magnetic Field

Researcher: Professor Robert A. Granger

This study is a theoretical investigation of a magneto-hydrodynamic free-convection flow past the unsteady motion of a hot vertical plate having variable suction. It is an extension of the work of Lighthill and Stuart, who studied a stationary plate with no free-convection or magnetic field. Soundalgekar added a magnetic field and variable suction. The results of the above investigators showed a reversal of flow when the plate moves in a direction opposite to the flow, a velocity decrease with increase Hartman number (R_h = (magnetic force)/(viscous force)), and that the velocity profile decreases with increase in suction (providing there is no back flow near the wall).

In the present investigation, the researcher shall study the unsteady free-convection with variable suction of an incompressible, electrically conducting viscous fluid over a vertical hot flat plate moving exponentially with time in its our plane. The researcher shall first investigate temperature to vary exponentially with time at the boundary.

It is important that the suction velocity varies exponentially with time because we wish to remove the retarded fluid from the boundary layer as quickly as possible in order to prevent flow separation. The magnetic field should lower the velocity profile as increases.

The researcher will consider exponential flow since it is believed relevant to the treatment of cardiovascular diseases (like tachycardiac disease). It is fairly well known that cardiovascular flow in humans follows exponential profiles. In the first phase of the theoretical investigation, exponential flow of a Newtonian fluid will be investigated, knowing that it is not Newtonian. This is the easier of two possible investigations. The easier investigation will provide an insight into the various physical mechanisms that will provide constraints on the experimental investigation.

Water on Mars

Researcher: Professor Robert A. Granger

This book is a treatise dealing with one of the classical mysteries today: namely, is there or has there ever been any water on the planet Mars? The only positive answer to this question will come with landing man on Mars. Since this may not take place for another decade, we can make certain qualified estimates using carefully controlled scientific measurements. Scientists have made spectacular evaluations in the past 15 years based on studying photographs and technical data from

two important space flight missions. These scientists presented their findings at international symposiums as well as published their technical papers in refereed international scientific journals. By the way, this was after considerable scrutiny by experts in their field. Every pitfall, each assumption and premise was meticulously examined. Experimental errors, bias and appropriateness of reference data was questioned. Many of the experimental conclusions were supported by elegant mathematical models lending further credence to their conclusions. These models also had imposed assumptions necessary to make the theory tractable and solvable.

Water on Mars plays perhaps the single most important role in sustaining l . Obviously without it, man has a limited time on Mars. But if there is water, be it surface ice, subterranean liquid water, or water vapor, then man can pursue the possibilty

of establishing colonies on Mars.

Mars is the third smallest planet, the fourth planet from our Sun, and has evoked the curiosity of scientists and writers for centuries largely because of the possibility that life had or might exist there. After the invention of the telescope in the early seventeenth century, astronomers discovered surface markings on Mars's surface that were attributed to canals and seas. Canals conjured up images of intelligent life, and novelists took it from there. Additional studies by astronomers showed Mars's rotation was similar to earth's. It had polar caps, clouds and storms, soaring volcanoes and huge rift valleys. It was revealed that Mars is more earth-like than any of the other planets in our solar system, so it is a national quest to explore it, despsite its hostile environment. Supported by the USNA while on sabbatical leave to Yale University 80% complete.

The Fluid Dynamics of Quantum Cosmology

Researcher: Professor Robert A. Granger

This is a new book dealing with the fluid behavior of the cosmogenesis of this universe in the interval of time $0 < t \le 10_{-43}$ secs. It also will treat the fluid dynamics of black holes. This book makes extensive use of the work of S. Trivedi.

Hawking's discovery of black hole radiance raises several intriguing questions. It shows that black holes have an entropy which can be elegantly expressed in terms of their geometry but which remains mysterious in terms of any underlying microstates. It also suggests that because of the thermal nature of the outgoing radiation, a loss of quantum coherence might occur in processes involving black holes. Extremal black holes provide a convenient setting in which to address both these issues. Their zero temperature suggests that their entropy should be explained in terms of a degeneracy of ground states. It also makes them convenient toy laboratories in which to study scattering and a potential loss of quantum coherence.

In this book the researcher studies a model consisting of dimensionally reduced gravity and electromagnetism coupled to two-dimensional scalar

fields. Classically, this model has Reissner-Nordstrom black hole solutions, obtained from dimensionally reducing the usual four-dimensional charged black hole solutions. We concentrate for the most part on the extremal black holes which in Planck units have a mass equal to their charge and have zero Hawking temperature. We show that, contrary to expectations, the quantum stress tensor of a scalar field in the background of such an extremal black holes blows up at the horizon. This raises the possibility of their geometry being drastically modified in the vincinity of the horizon and their entropy being very different from what classical considerations would suggest. A semiclassical calculation of their quantun-corrected geometry shows, however, that this is not true. For large black holes, the value of the dilation at the horizon and, hence, their entropy, stays large. A singularity does appear at the horizon, but it is very mild. For example, tidal forces and the curvature stay finite at the horizon. This suggests that there should be a continuation of the geometry past the horizon.

Coherent Structures in Turbulent Flows

Researcher: Professor Robert A. Granger

Work continues on researching coherent structures in turbulent flows. Coherent structures are regions of concentrated vorticity. This investigation is an outgrowth of the Principal Investigators work in vortex turbulence. The concept is that turbulence has an organized structure and need not be analyzed statistically. Different structures are related to different flows. For shear flows, there are two coherent scales. The small scale with longitudinal vortices is responsible for turbulence energy production, and the large scale takes care of part of the diffusion. The current research is on the mixing layer, where the inviscid (inflection point) instability is dominant. Here, the flow is relatively simple, with both large scale (ring vortices or line vortices) and small scale (longitudinal vortices connecting large scale structures).

The Stability of a Liquid in a Magnetic Field

Researcher: Professor Robert A. Granger

A theoretical solution of the stability of a viscous fluid flowing down an inclined flat plate in a magnetic field is presented. It is shown that if the longitudinal magnetic field is directed opposite to the flow, the flow can be stable at sufficiently large values of magnetic strength, even for vertically inclined plates.

The coupled linear second degree magnetohydrodynamic equations are solved in closed analytic form in terms of the Alfven number, the hydrodynamic Reynolds number, the magnetic Reynolds number, Frouke number and Hartman number. For wave motions, the solutions would include Granger number.

Optimum Power Predictions for Real Time Combined Cycles

Researchers: Professors Vincent J. Lopardo and Chih Wu

In this paper two endorevesible engines operate in series as a combined cycle with all heat transfers occurring across finite temperature differences. The power is optimized with respect to the four unknown operating system temperatures and expressions obtained which are amenable to computer solution. An example is presented and an approximate solution is also presented which facilitates the use of some common computer software.

Potential Flow Analysis of Centrifugal Pumps

Researcher: Assistant Professor Steven M. Miner

This is an ongoing project to develop an anlysis technique for studying the flow field within volute or diffuser type centrifugal pumps. Two-dimensional potential flow is used to model the potential field within the impeller and the volute or diffuser. The rotating and stationary components are modeled together to capture the interaction that takes place between these components. The potential field results are then used to calcualte momentum and pressure unbalance forces on the impeller.

The previous years efforts have focused on performing quasi-static analyses, the current effort includes the transient effects in the analysis. These transient effects are included by adding the transient

term to Bernoulli's equation. This transient term affects the pressure field, which in turn has effects on the pressure unbalance force. At this time the transient term has been incorporated, and analysis of a volute type centrifugal pump is underway.

After completion of the volute pump, a diffuser pump analysis will be performed.

The project was supported by Ingersoll Rand Company.

Fluid-Structure Interactions in Composite Structures

Researchers: Assistant Professors Raouf A. Raouf, and
Steven M. Miner

The behavior of a structure submersed in a fluid, such as the wing of an aircraft in flight or the hull of a ship or a submarine, is subjected to fluid loading which causes it to deform. On the other hand, the deformation of the structure causes a change in the fluid loading. This phenomena, called fluid-structure interaction is of interest to both the structural engineer who designs the structure and the fluid dynamicist who predicts the fluid loading. The conventional approach to this problem has been mostly one-sided, i.e., the structural engineer assumes the fluid loading to be independent of the structural deformations while the fluid dynamicist assumes the structure to be rigid. This research attempts to bridge the gap between these two approaches by combining the expertise of two faculty members in the Mechanical Engineering Department to study the full coupled fluid-structure interaction problem. Preliminary results on the behavior of laminated compressor blades have been presented at the Joint ASME, ASCE, SES Technical Conference, June 1993, at the University of Virginia, Charlottesville, Virgina. Another paper is in preparation.

Nonlinear Thermal Effects in Composites

Researchers: Assistant Professor Raouf A. Raouf and
Lieutenant Commander James R. Nault, USN

Many composite structures operate at high temperatures and in severe operational conditions that drive them into their nonlinear regimes. This research studies the thermally induced nonlinear effects in composite structures. The preliminary work studies the nonlinear thermal effects in thick orthotropic plates. The results have been presented at the Joint ASME, ASCE, SES Technical Conference, June 1993, at the University of Virginia, Charlottesville, Virgina.

Shear Banding and Plastic Deformations

Researcher: Assistant Professor Raouf A. Raouf

Shear bands are areas of intense shear strain concentration that occur during high speed plastic deformations; they usually precede rupture. This project investigates analytical and computational approaches to study the shear band phenomenon. The plasticity model used is based on generic power law constitutive relationships.

Research Course Projects

Development of a Battery Container for use in the SAE Hybrid Electric Vehicle Challenge

Researcher: Midshipman 1/C John D. Boone, USN
Adviser: Assistant Professor Gregory W. Davis

A hybrid electric vehicle has been developed for use in the Hybrid Electric Vehicle Challenge co-sponsored by SAE, Department of Energy, and Ford Motor Company. Ten 12-volt batteries will be used to propel the vehicle. The battery container must be able to support the batteries in the event of a roll-over accident and, additionally, must isolate the gaseous emissions of the batteries from the vehicle occupant compartment. Additionally, the batteries must be cooled and ventilated through the use of external duct-work and blower. This project required the design and development of this container. This project is complete and has satisfactorily met the challenge criteria during June of 1993.

Adaption of a Eight-Cylinder Engine to a Water-Brake Dynamometer of use in Engine Studies

Researcher: Midshipman 1/C Andrew T. Fitzpatrick, USN
Adviser: Assistant Professor Gregory W. Davis

An eight-cylinder, spark-ignited engine manufactured by General Motors Corp., was donated to the Mechanical Engineering Department. Before this engine could be utilized for research, extensive electrical and mechanical design modifications were made to allow the engine to be safely coupled to a water-brake dynamometer. These modifications included the design and manufacture of electrical feedback devices to mimic those signals normally produced in an operating vehicle, a fly-wheel transmission adapter plate, and vibration isolating engine mounts. This project was complicated due to the general lack of available printed information, much of the electrical work had to be completed with the telephone advice of various GM engineers. This project is still in progress, additional mechanical and electrical modifications are still in progress.

Adaptation of a Rotary Engine to a Water-Brake Dynamometer for use in Engine Studies

Researcher: Midshipman 1/C Monte D. Ten Kley, USN
Adviser: Assistant Professor Gregory W. Davis

A twin rotor, turbo-charged spark-ignited engine manufactured by Mazda Corp., was donated to the Mechanical Engineering Department. Before this engine could be utilized for research, extensive electrical and mechanical design modifications were being made to allow the engine to be safely coupled to a water-brake dynamometer. These modifications included the design and manufacture of electrical feedback devices to mimic those signals normally produced in an operating vehicle, a fly-

wheel transmission adapter plate, and vibration isolating engine mounts. This project was complicated due to the general lack of available printed information, much of the electrical work had to be completed, with the telephone advice of various Mazda engineers. This project is not yet complete, additional electrical modifications are still in progress.

Adaptation of a Four-Cylinder Engine to a Water-Brake Dynamcmeter for use in Engine Studies

Researcher: Midshipman 1/C Kenneth A. Krueger, USN
Adviser: Assistant Professor Gregory W. Davis

A four-cylinder, spark-ignited engine manufactured by Saturn Motors Corp., was donated to the Mechanical Engineering Department. Before this engine could be utilized for research, extensive electrical and mechanical design modifications were being made to allow the engine to be safely coupled to a water-brake dynamometer. These modifications included the design and manufacture of electrical feedback devices to mimic those signals normally produced in an operating vehicle, a fly-wheel transmission adapter plate, and vibration isolation engine mounts. This project was complicated due to the general lack of available printed information, much of the electrical work had to be completed with the telephone advice of various Saturn engineers. This project is almost complete, some minor electrical problems are currently preventing full-load operation of the engine.

Fabrication and Evaluation of Filament-Wound Composite Shafts for Future Naval Applications

Researcher: Midshipman 1/C Lynn Andrew Gish, USN
Adviser: Professor Dennis F. Hasson

The quality of filament-wound composite shafts was evaluated. Five shafts were produced using different resins to determine the effect resin has on shaft quality. Scanning electron microscopy and void content determinations were used to evaluate the shafts. In addition, a commercially-wound shaft was compared to the research shafts. It was shown that shaft quality is not resin dependent, provided the resin viscosity is above a certain level. Rather, quality is processing dependent. Unexpectedly high void contents were observed in the glass plies of all shafts. Finally, the commercial shaft had comparable but slightly better quality than the research shafts.

The Effects of Oxidation Embrittlement on the Impact Behavior of Nicalon Reinforced CAS II Ceramic Matrix Composites

Researcher: Midshipman 1/C Lynn Andrew Gish, USN
Adviser: Professor Dennis F. Hasson

The impact behavior of Nicalon reinforced CAS II composites is described. It is demonstrated that oxidation embrittlement has a negative effect on the maximum stress and dynamic fracture toughness of CAS II composites when fractured in impact. It is further demonstrated that specimens reinforced with mica-coated Nicalon fibers are more susceptible to oxidation embrittlement than specimens reinforced with standard Nicalon fibers. Impact tests of samples loaded to 1.0 micro-cracking yield and

heated to 600°C for 10 hours are compared to tests of as received samples to determine the degree of degradation. In addition, a sample which was loaded to 1.0 micro-cracking yield but not heated is compared to a thermal treated sample to isolate the effects of pre-cracking and heating. The effect of notch orientation on dynamic fracture toughness is also described.

Development of a Motorcycle Engine for use in the SAE Formula Car Challenge

Researcher: Midshipman 1/C Brian R. Perry, USN
Adviser: Assistant Professor Gregory W. Davis

A 600cc, spark-ignited motorcycle engine manufactured by Honda Corp., was donated to the Mechanical Engineering Department. Before this engine could be utilized in the Formula Event, extensive electrical and mechanical design modifications were to be made. These modifications include the installation of a new fuel and air induction systems. This project is not yet complete, many additional modifications remain to be completed.

Hybrid Electric Vehicle Challenge

Researcher: Midshipmen HEV Challenge Team
Advisers: Captain Frank C. Madeka, USAF, Assistant Professor Gregory W. Davis, and Lieutenant Gary Hodges, USN

The United States Naval Academy is one of 30 universities and colleges across North America selected to compete in the Hybrid Electric Vehicle (HEV) Challenge. An Hybrid Electric Vehicle with an auxiliary power unit used in conjunction with, or as a supplement to, the main electric battery source. The Hybrid Electric Vehicle Challenge will focus on the use, advancement, and development of Hybrid Electric Vehicles. The Hybrid Electric Vehicle Challenge will culminate with a competition held in Dearborn, Michigan during the first week in June 1993.

Publications

DAVIS, Gregory W., Assistant Professor, Gary L. HODGES, Lieutenant, CEC, USN, and Franck C. MADEKA, Captain, USAF, "The Development of a Series Hybrid Electric Vehicle for Near-Term Applications," *Proceedings* of the 28th Intersociety Energy Conversion Engineering Conference, 8 August 1993, SAE #93182, Vol. 2, pp. 239-244.

A series of Hybrid Electric Vehicle (HEV) is currently under development for use in the Hybrid Electric Vehicle Challenge which is scheduled to take place during June of 1993. This competition is jointly sponsored by Ford Motor Company, the Society of Automotive Engineers, and the Department of Energy. The U.S. Naval Academy's entry is a 5-door Ford Escort Wagon with a manual transmission which has been converted to a series drive hybrid electric vehicle. The propulsion system is based on a DC motor which is coupled to the existing transmission. Lead-acid batteries are used to store the electrical energy. The auxiliary power unit (APU) consists of small gasoline engine connected to a generator. Regenerative braking is accomplished using a small alternator. For safety, the conventional braking system has been retained. The AMPhibian is designed to be an economically feasible HEV, for use in near term applications. To accomplish this, all components are based upon

existing technology. Further, this vehicle was designed to retain, to the greatest degree possible, the basic driving characteristics of a conventional gasoline powered vehicle. The major performance design goals for the AMPhibian include (1) the ability to travel 64 Km as a zero emissions vehicle (ZEV) using battery power alone, (2) operating in hybrid mode, the ability to travel 320 Km while meeting the transitional low emissions vehicle (TLEV) air pollution standards, (3) achieve a time of under 15 seconds when accelerating from 0 to 70 Kph, and (4) climb a minimum of a 15% grade. The design specifications, including the functional system schematic and physical layout are provided in the report. Preliminary results of the performance and emissions testing are reported and compared with the original gasoline powered vehicle.

HABERLIN, Gail M., Lieutenant, USN, co-author, "Predicting Solvent Concentrations from Coating the Inside of Bulk Storage Tanks," *Advances in Industrial and Environmental Hygiene Journal*, 57 (January 1993), 1-9.

A technique is presented to assess health risks associated with coating the inside surface of a bulk storage tank. The technique uses a sequential box model to predict the time-varying solvent concentrations at arbitrary points inside the vessel during an ongoing coating process. Input parameters include volumetric flow rates of exhaust and makeup air, solvent threshold limit values and evaporation rates, and a set of exchange coefficients that characterize air circulation inside the vessel. This technique enables engineers to rate quantitatively the anticipated health risks of applying a combination of coatings. The technique also provides engineering managers a predictive tool to organize work schedules so that health and safety can become input parameters to an engineering enterprise.

HAMM, Michael K., Lieutenant, USN, and Dennis F. HASSON, Professor, "The Effect of Temperature on the Impact Behavior of TiB_2 Reinforced XD^{TM}- TiAl Intermetallic Matrix Composites," Division of Engineering and Weapons Report, EW-23-92.

The specimens were notched to an a/w ratio of 0.2. Details and test procedures for the modified apparatus were presented. Test temperatures ranged from -192°C to 1100°C. Impact toughness and maximum bending stress for both IMC's

decreased from room temperature to temperatures as high as 1100°C. An important experimental observation which supports the results is the change from transangular cleavage to intergranular fracture the 760°C test temperature. Also noted is the possible contribution to decreasing toughness of unfavorable difference in coefficient of thermal expansion between TiB_2 and the matrix with increasing temperature. Data repeatability and verification of the ability to observe high temperature brittle ductile transition behavior established confidence in the modification of existing instrumented test apparatus.

JOYCE, James A., Professor, co-author, "Load Ratio Method for Estimating Crack Extension," Fracture Mechanics: Twenty-Second Symposium (Volume I), ASTM STP 1131, eds. H.A. Ernst, A. Savena, and D. L. McDowell, American Society for Testing and Materials, Philadelphia, 1992, pp 880-903.

This paper presents a method for estimating crack extension of typical fracture specimens from a continuous plot of measured load versus load-line displacement, without having to unload the specimen periodically so that crack extension can be inferred from elastic compliance. If periodic unloadings were not needed, the test methods for determining the J-R and CTOD-R curves could be much simplified. As a result, the resistance curve could be measured at dynamic loading rates, in which case it is not possible to unload the specimen periodically. It could be also measured in corrosive environment tests in which unloading may affect crack growth behavior.

JOYCE, James A., Professor, co-author, "Use of J-R Curves in Assessing the Fracture Behavior of Low Upper Shelf Toughness Materials," Nuclear Engineering and Design, 134 (1992), 217-226.

The objective of this investigation was to evaluate the use of small specimen J-R curves in assessing the fracture resistance behavior of reactor vessels containing low upper shelf (LUS) toughness weldments. As required by the U.S. Code of Federal Regulations (10 CFR, Part 50), reactor vessel beltline material must maintain an upper shelf Charpy V-Notch (CVN) energy of at least 50 ft-lbs (68 J) throughout vessel life. If CVN values from surveilliance specimens fall below this value, the utility must demonstrate to the U.S. Nuclear Regulatory Commission (NRC) that the lower

values will provide "margins of safety against fracture equivalent to those required by Appendix G of the ASME Boiler and Pressure Vessel Code." This paper will present recommendations regarding the material fracture resistance aspects of this problem and outline an analysis procedure for demonstrating adequate fracture safety based on CVN values.

It is recommended that the deformation formulation of the J-integral be used in the analysis described above. For cases where J-integral fracture toughness testing will be required, the ASTM E1152-87 procedure should be followed, however, data should be taken to 50% to 60% of the specimen remaining ligament. Extension of the crack growth validity limits for J-R curve testing, as described in E1152-87, can be justified on the basis of a "J-controlled crack growth zone" analysis which shows an engineering basis for J-control to 25% to 40% of the specimen remaining ligament. If J-R curve extrapolations are required for the analysis, a simple power law fit to data in the extended validity region should be used. The example analysis performed for low upper shelf weld material, showed required CVN values for a reactor vessel with a 7.8 inch (198 mm) thick wall ranging from 32 ft-lbs (43 J) to 48 ft-lbs (65 J), depending on the magnitude of the thermal stress component.

JOYCE, James A., Professor, "J-Resistance Curve Testing of Short Crack Bend Specimens Using Unloading Compliance," Fracture Mechanics: Twenty Second Symposium (Volume I), ASTM STP 1131, eds. H. A. Ernst, A. Saxena, and D. L. McDowell, Philadelphia, Pennsylvania: American Society for Testing and Materials, 1992, pp. 904-924.

The majority of cracks present in U.S. Navy structures are short. It has been proposed that for these cracks the crack-tip constraint will be much lower than that of standard ASTM J_{Ic} and J-R curve specimens as defined by ASTM Test Method for J_{Ic}, a Measure of Fracture Toughness (E813-87) and ASTM Test Method for Determining J-R Curves (E1152-87) and thus, that the fracture toughness values obtained by these methods will be very cooperative. For this reason, tests have been conducted by the Navy using multispecimen elastic-plastic J-integral methods to characterize the short crack fracture toughness of U.S. Navy structural steels.

This work presents a method to obtain J-resistance curves from short cracked three-point-bend specimens using an unloading compliance method. Specimens with a/W values as small as 0.15 were tested successfully. Also presented is a discussion of two methods that are used to develop J for the short crack geometry from the experimental data using (1) an incremental method similar to ASTM E1152-87 and (2) a key-curve method.

Both methods use a plastic η-factor and this factor is calculated from elastic-plastic finite element calculations as well as from the EPRI Handbook and from published work of Sumpter. This η-factor falls below the deep crack value of 2.0 if the a/W is less than 0.28. application of the lower η-value to the measured data was found to give J-R curves that are somewhat elevated above those obtained using the standard ASTM E1152-87 method and deeply cracked specimens.

The principal results are found that unloading compliance can be utilized for three-point-bend (3PB) specimens for a/W values as small as 0.15 and that the resulting J-R curves are elevated above those of deeply cracked specimen tests if the correct η-factors are used. The two methods of J-evaluation were found to give very consistent J-R curves for standard and deeply cracked bend specimens. The incremental method of J-evaluation gives J-resistance curves for short cracked specimens that are elevated above the J-R curves of deeply cracked specimens. The key-curve method of J-elevation results in somewhat lower J-R curves for short cracked specimens-but still, the results are elevated in comparison with J-R curves of standard crack length specimens. It appears that unloading compliance could be used for specimens with a/W at least as small at 0.1.

The toughness elevation demonstrated by this material in the short crack case is very small, even when the crack had an a/W ratio as small as 0.15, and the use of standard toughness values obtained on deeply cracked specimens would give only a small measure of conservatism.

JOYCE, James A., Professor, co-author, "Comparison of J_{Ic} and J-R Curves for Short Crack and Tensilely Loaded Specimen Geometries of a High Strength Structural Steel," U.S. Nuclear Regulatory Commission Report, NUREG/CR-5879, December 1992.

This paper describes an experimental program which had the objective of developing a series of J-R curve data from laboratory specimens of varied constraint. Constraint was varied by testing specimens with different thicknesses, crack lengths,

and mode of loading. All specimens were relatively small and were kept simple in geometry and loading to allow estimation of the applied J integral. Crack length to width ratios were varied from a/W = 0.10 to a/W = 0.66 and the mode of loading ranged from three point bending of deeply cracked edge notched bars to pure tensile loading of double edge notched strips. All tests were conducted on a single material, a high strength structural steel at ambient temperature, which on the ductile upper shelf for this alloy.

Short cracked bend specimens were tested, corresponding to a case of decreased crack tip constraint. It is shown that the J_{Ic}'s and the J-R curves are elevated in the case of short cracked bend specimens, even when η and γ factors consistent with the short crack geometry are used. It is demonstrated that short crack bend specimens can be successfully tested using unloading compliance procedures even with crack lengths as short as a/W = 0.10. Single edge notch tensile specimens and double edge notched tensile specimens were also tested in this program. Unloading compliance procedures were used successfully for these specimens as well. Two dimensional finite element calculations were done to develop the needed compliance equations and the η factor equations for these non-standard specimen geometries.

Results of these tests have shown that different constraint conditions can dramatically affect the J_{Ic} and the J-R curve for the full range of crack lengths and loading modes studied here, and these effects can be studied on relatively inexpensive laboratory specimens. The results are compared in terms of the "T Stress" (T_{σ}) parameter and the Q constraint parameter, but the trends in the data do not seem to correlate well with either parameter. Although both the T_{σ} and Q parameters predict that the single edge notched tensile bar (SE(T)) would have relatively high constraint, this geometry demonstrated the highest J_{Ic} properties. On the other hand, the double edge notched bars were predicted by the T_{σ} or Q parameters to be a low constraint geometry, however this geometry resulted in J_{Ic} results lower than those measured on standard deeply crack bend bars. If only the short and deep crack bend specimens had been tested these conclusions could have been dramatically different. The testing of predominantly tensile specimens seems essential to the understanding of the effect of constraint on fracture toughness.

The tearing resistance or J resistance curve slope was found to correlate in a much more consistent manner with the predictions of the T_{σ} or Q parameters, through the effect of constraint on the J-R curve slope is apparently small for this alloy.

MORAN, Patrick J., Associate Professor, co-author, "Corrosion and Corrosion Control, "Kirk-Othemer Encyclopedia of Chemical Technology," 4th Edition, Vol. 7, pp. 548-572.

This encyclopedia article presents the various forms of corrosion, discusses the mechanisms responsible for each, and outlines methods of prevention. Specific examples from technologically significant alloy systems are presented throughout the article.

MORAN, Patrick J., Associate Professor, co-author, "Effect of Microstructure on Passive Film Formation and Breakdown of Al-Ta Alloys," *Faraday Discussions*, 94 (1992), 127-136.

Two in situ techniques dynamic imaging microellipsometry (DIM) and local impedance spectroscopy (LEIS), have been applied to a study of the effect of microstructure on passive film formation and breakdown on Al-Ta alloys. DIM acquires ellipsometric data (thickness and optical constants of the films on surfaces) at a spatial resolution of ca. 20 μm using a radiometric full-field imaging approach. LEIS is an electrochemical impedance technique that generates local a.c. impedance data by measuring a.c. solution current densities very near the microstructural features of an electrode surface. The DIM technique was used to look at passive film formation at (a) the Al_3Ta precipitate, (b) the dealloyed zone adjacent to the precipitate and (c) the solid solution phase that is present in Al-Ta alloys. The DIM technique observed different film thicknesses and optical constants for the films that form on these phases at potentials in the passive regions. The LEIS technique was used to study the precipitate and the region surrounding it under conditions where passive film breakdown occurs. Using these techniques, insight was obtained into the passive film formation and breakdown processes that control localized corrosion.

MORAN, Patrick J., Associate Professor, co-author, "The Anodic Behavior of Iron in Anhydrous Dimethoxyethane and Passivation by Solvent Electropolymerization," *Journal of the Electrochemical Society*, 140, 5 (May 1993), 1268-1275.

MECHANICAL ENGINEERING

The corrosion and passivity of high purity iorn in anhydrous dimethoxyethane with 0.5M LiAsF$_6$ have been studied by various electrochemical and surface analytical techniques. The motivations for this study were twofold; (1) to develop an understanding of the passivity of metals and alloys in anhydrous organic solutions at a fundamental level, and (2) to apply what is learned to improve the performance and useful life high energy density lithium batteries which employ organice solvents. The data show that iron displays a stable passive region with low current densities over a large range of anodic potentials. Several different passivation mechanisms have been identified in this stable region. Among these mechanisms is passivation by solvent chemisorption. Our key finding is the observation of passivation by electropolymerization of the dimethoxyethane solvent. The polymerization reaction has not been observed when electrolytes other an LiAsF$_6$ are used. Consequently, the potential at which breakdown of passivity occurs is lower in solutions containing alternative electrolytes. In addition, a bare oxide-free metal surface appears necessary for initiation of the electropolymerization reaction.

MORAN, Patrick J., Associate Professor, co-author, "Passivity of 1018 Carbon Steel in Dimethoxyethane with LiAsF$_6$-Observation of Electropolymerization," *Electrochimica Acta*, 38, 7 (1993), 881-888.

The passivity and breakdown of passivity of 1018 carbon steel in dimethoxyethane with 0.5M LiAsF$_6$ was studied by electrochemical and surface analytical techniques. Carbon steel exhibits passivity over a large anodic potential range. Several different passivation mechanisms, including solvent adsorption, operate in this potential domain. In addition, another passivation mechanism involving electro-polymerization of the solvent and complexation the LiAsF$_6$ was observed. A polymer film did not form in supporting electrolytes other than LiAsF$_6$. The effects of small amounts of water on the extent of the passive region and the possibility of polymer growth are discussed.

MORAN, Patrick J., Associate Professor, co-author, "Evaluation of as received Corrosion Resistant Coatings on Fasteners for Shipboard Topside Combat Systems Part II," Division of Engineering and Weapons Report EW-15-92, July 1992.

This report is presented in support of the joint effort between the United States Naval Academy

and the Naval Surface Warfare Center in determining the corrosion resistance performance of combat systems topside fastener coating systems.

Information herein details specific findings and observations of as received fastener coating coverage and thickness measurements through the use of precision computerized image analysis techniques. These observations are then used to predict in service corrosion resistance performance.

The particular commercial coatings evaluated in this report are: Sermatel 725, and Sermatel 725 with 570A topcoat.

MORAN, Patrick J., Associate Professor, co-author, "Evaluation of Corrosion Resistant Coatings for Shipboard Fasteners using Electrochemical Impedance Spectroscopy and Immersion Testing," Division of Engineering and Weapons Report EW-18-92, September 1992.

This report is presented in support of the joint effort between the United States Naval Academy and the Naval Surface Warfare Center in determining the corrosion resistance performance of combat systems topside fastener coating systems.

Information herein details specific performance results and observations of as received commercial fastener coating systems through the use of precision computerized electrochemical impedance spectroscopy and immersion testing.

The particular commercial coatings evaluated in this report are: Blue Armor II by ISPA\, NiCoTef by Nymet, and IC-531 by Inorganic Coatings.

These observations correlate well with conclusions determined in previous U.S. Naval Academy reports supporting this effort. This report recommends discounting the idea of coating use as a panacea in solving corrosion problems of fasteners used for AEGIS combat system topside applications and to pursue a solution from a materials standpoint.

WU, Chih, Professor, "Maximum Cooling Load of a Heat-Engine-Driven Refrigerator," *Energy Conversion and Management*, 34, 8 (October 1992), 691-696.

An endorversible heat-engine-driven refrigerator system to carry out the conversion of a high-temperature heat transfer into a cooling effect is modeled thermodynamically in this paper. The endoreversible system couples an external irreversible and internal reversible Carnot heat engine with a work-driven external irreversible and internal reversible Carnot refrigerator. The

maximum cooling load of such a combined device is analyzed.

WU, Chih, Professor, co-author, "Combustion Effect on Endoreversible Otto Cycle," *Journal of the Institute of Energy*, 65, 463 (June 1992), 86-89.

The work potential of an endoreversible Otto cycle with combustion is analysed and optimised. (An endoreversible cycle is one which the heating process by combustion and the heat-removal process to the surroundings are the only irreversible processes in the cycle.) A mathematical expression is derived and optimised for the work output of the cycle. This paper provides a criterion other than thermal efficiency, mean effective pressure or detonation for the evaluation of the performance and suitability of an Otto engine.

WU, Chih, Professor, "Potential Power Output of a Global Wind System," *Journal of Wind Engineering*, 15, 5 (1992), 291-297.

The earth and its atmosphere are modeled as a Global Wind Power System. The atmosphere air is considered as the working fluid of the Global Wind System. The system receives its heat from the solar sun during daytime, rejects its heat to space and produces wind power. A mathematical expression is derived for the potential power output of the Global Wind System. Numerical results show good agreement with the observed wind power value.

WU, Chih, Professor, and Gabriel KARPOUZIAN, Assistant Professor, co-authors, "Power Optimal Performance of an Endoreversible Combined Cycle, *Journal of the Institute of Energy*, 65, 462 (1992), 41-45.

An optimal-performance analysis of an endoreversible combined cycle (two single endoreversible cycles in a cascade) was carried out, and the maximum power and the efficiency at maximum power for steady-state operation were obtained. These two performance factors, measured against those of a single cycle, can be expressed in terms of two design parameters, and the consequences of varying one parameter were examined in detail. It was shown that as regards efficiency the combined cycle is superior to the single cycle for all values of that design parameter; and as regards power output, only beyond a certain value of that parameter is the combined cycle superior to the single cycle.

WU, Chih, Professor, co-author, "Effect of Human Power Consumption on the Global Wind System," *International Journal of Ambient Energy*, 13, 2 (1992), 99-102.

The earth and its atmosphere is modelled as a global wind power system. The atmosphere air is the working fluid of the novel wind heat engine. The wind heat engine receives its heat from the solar sun and human power consumption, rejects its heat to the space and produces wind power. A mathematical expression is derived for the potential power output of the global wind system with the effect of human power consumption. The result shows that although the effect is small at the present time, it may be significant in the future if the human power consumption continues to grow exponentially.

WU, Chih, Professor, co-author, "Finite-Time Thermodynamic Analysis of a Carnot Engine with Internal Irreversibility," *Journal of Energy*, 17, 12 (1992), 1173-1178.

This paper extends Curzon and Ahlborn's result which gives a thermodynamic efficiency of an endoreversible Carnot engine. It is shown that the internal irreversibilities of a Carnot engine can be characterized by a single parameter representing the ratio of two entropy differences. Named the cycle irreversibility parameter, the presence of this parameter in the equations for maximum power and efficiency clearly shows that an engine with internal irreversibilities delivers less power and has a lower efficiency than an endoreversible engine.

WU, Chih, Professor, "Cooling Capacity Optimization of a Waste Heat Absorption Refrigeration Cycle," *Journal of Heat Recovery Systems and CHP*, 13, 2 (1992), 161-166.

A finite-time endoreversible heat-driven absorption refrigerator is modeled thermodynamically in this paper. The refrigerator uses a log-temperature waste heat directly to provide a cooling effect. The maximum cooling capacity delivered by the absorption system is analyzed.

WU, Chih, Professor, "Cooling Capacity Optimization of a Geothermal Absorption Refrigeration Cycle," *Journal of Ambient Energy*, 13, 3 (1992), 133-138.

A finite-time endoreversible heat-driven absorption refrigerator is modeled thermodynamically in this paper. The refrigerator uses low-temperature geothermal heat transfer directly to provide a cooling effect. The maximum cooling capacity delivered by the absorption system is analyzed.

WU, Chih, Professor, "Optimal Power from a Radiating Solar-Powered Thermionic Engine," *Journal of Energy Conversion and Management*, 33, 4 (1992), 279-282.

A finite-time thermodynamic analysis is given of the thermionic engine as a direct converter of heat to electricity. The engine is coupled to a radiant solar input and is radiatively coupled to a heat sink. Both the heat source and heat sink are assumed to have infinite heat-capacity rates. The characteristics of the engine are determined when it is operating at maximum power.

WU, Chih, Professor, "Power Output of a Solar Pond Heat Engine," *Journal of Ambient Energy*, 13, 4 (1992), 183-188.

A power output limit of a solar heat engine is analyzed from a finite-time thermodynamic point of view. The pond's water is viewed as the working fluid of a heat engine where the heat input is solar radiation and heat rejection is to the ambient air.

WU, Chih, Professor, "Maximum Cooling Load of a Heat-Engine-Driven Refrigerator," *Journal of Energy Conversion and Management*, 34, 8 (1993), 697-706.

An endoreversible heat-engine-driven refrigerator system to carry out the conversion of a high-temperature heat transfer into a cooling effect is modeled thermodynamically in this paper. The endoreversible system couples an external irreversible and internal reversible Carnot heat engine with a work-driven external irreversible and internal reversible Carnot refrigerator. The maximum cooling load of such a combined device is analyzed.

WU, Chih, Professor and David A. BLANK, Lieutenant Commander, Retired, "The Effect of Combustion on a Power Optimized Endoreversible Diesel Cycle," *Journal of Energy Conversion and Management*, 34, 6 (1993), 493-498.

The power potential of an endoreversible Diesel cycle with combustion is analyzed and optimized. The endoreversible cycle is one in which the heating process by combustion and the heat removing process to the surroundings are the only irreversible processes in the cycle. A mathematical expression is derived and optimized for the power output of the cycle. This paper provides another criterion besides thermal efficiency, mean effective pressure and detonation for use in the evaluation of the performance and the suitability of a diesel engine.

WU, Chih, Professor, "Analysis of an Endoreversible Stirling Cooler," *Journal of Energy Conversion and Management*, 34, 12 (1993) 1249-1253.

An internally reversible and externally irreversible Stirling refrigeration cycle which achieves cryogenic temperatures in a single stage is presented in this paper. The equations relating the maximum cooling load, working fluid temperatures and power input of the cryocooler are found. These relationships provide a base for practicing engineers to design a new cryocooler.

WU, Chih, Professor, "Heat Transfer Effect on the Specific Power Availability of Heat Engines," *Journal of Energy Conversion and Management*, 34, 12 (1993), 1239-1247.

The maximum possible specific power (specific power availability) that can be obtained from heat engines with a set of high temperature heat source and low temperature sink is analyzed. The heat engines considered in this paper include (1) externally and internally reversible, (2) externally irreversible and externally reversible, (3) externally reversible and internally irreversible, and (4) externally and internally irreversible engines. The irreversibilities are assumed caused by heat transfer only. The specific power, defined as the power output per unit total heat exchanger surface area, is adopted as the objective function in determining power economics in this paper.

WU, Chih, Professor, "Specific Heating Load of an Endoreversible Carnot Heat Pump," *Journal of Ambient Energy*, 14, 1 (1993) 25-28.

An endoreversible Carnot cycle is presented in this paper for a heat pump, where the specific heating

load is limited by the power input. The endoreversible Carnot cycle is a modified Carnot cycle where the heat transferred between the heat pump and its surroundings is irreversible. A specific heating load is adopted as the objection function for the performance analysis of the heat pump. The relation between the maximum specific heating load and power input of the heat pump is found.

WU, Chih, Professor, "Optimization of the Endoreversible Otto Cycle with Respect to both Power and Mean Effective Pressure," *Journal of Energy Conversion and Management*, 34, 12 (1993), 1255-1259.

The output response of an endoreversible Otto cycle with combustion is optimized with respect to both power and mean effective pressure. The endoreversible cycle is one in which the heating process by combustion and the heat removing process to the surroundings are the only irreversible processes in the cycle. Expressions for these two responses are derived and optimized and a comparative analysis of results conducted. This paper provides an additional criteria for use in the evaluation of the performance and the suitably of an Otto engine.

WU, Chih, Professor, "Specific Power Analysis of Thermoelectric OTEC Plants," *Journal of Ocean Engineering*, 20, 4 (1993), 433-442.

The specific power output of a real thermoelectric OTEC plant is analyzed and optimized. The thermoelectric OTEC is treated as an external and internal irreversible heat engine. The irreversibilities of the heat engine are limited to the factors of heat transfers and Joulean loss only. The specific power output of the real thermoelectric OTEC is then compared with that of the Carnot OTEC, endoreversible OTEC, and external reversible thermoelectric OTEC.

WU, Chih, Professor, "Performance of a Solar-Engine-Driven-Air-Conditioning System, *Journal of Ambient Energy*, 14, 2 (1993), 77-82.

Utilization of a solar-powered low-temperature Rankine cycle to operate a conventional mechanical compression air conditioning cycle is feasible in providing a cooling load. The aim of this paper is to use an endoreversible system approach for the analysis of the performance of such a solar-heat-engine-driven-air-conditioning system. The only irreversibilities are heat transfers due to finite temperature differences between the system and the three surrounding heat reservoirs.

WU, Chih, Professor, "A Computer Code for the Power Analysis of a Finite-Time Gas Power Plant," *Journal of Microcomputer Applications*, 12, 2 (1993), 61-67.

The power output of a simple, finite-time closed gas-turbine power plant is modeled and analyzed. The model adopted is a reversible Brayton cycle coupled to a heat source and a heat sink by heat transfer. Both the heat source and the heat sink may have either finite or infinite heat-capacity rates. A mathematical expression is derived for the power output of the irreversible power plant. The maximum power output of the power plant is found by computer simulation. The maximum bound provides the basis for designing a real closed gas-turbine power plant and for a performance comparison with existing power plants.

WU, Chih, Professor, "Nuclear Powered Gas Turbines: An Old Idea Whose Time Has Come," *Journal of Power and Energy Systems*, 13, 2 (1993), 33-39.

It is possible by combining proven technologies, to produce a closed cycle gas turbine engine in which the gas is heated by a nuclear reactor. The characteristics of the engine would include rapid start capabilities, rapid response uncertainties, small total plant volume, independence from oxygen, zero, air pollution, relatively low thermal pollution, and operation, reduced long term radioactive waste and acceptable lifetime cost.

WU, Chih, Professor, and Gregory W. DAVIS, Assistant Professor, "Performance of a Geothermal-Heat-Engine-Driven-Air-Conditioning System," *Proceedings* of the International Conference on New Energy Systems and Conversions, 27 June 1993, pp. 503-507.

A geothermal-heat-powered-low-temperature Rankine cycle used to operate a conventional mechanical compression air conditioning cycle is feasible in providing cooling load. This paper employs a finite-time thermodynamic approach to analyze the performance of such a system. The only irreversibilities are associated with the heat transfers between the system and the surrounding thermal

reservoirs. This approach provides a more realistic prediction of the performance than does the Carnot theoretical heat engine and air conditioning unit.

Presentations

ADAMS, J. Alan, Professor, "Spatial Reasoning for Procedural and Declarative Geometric Modeling," Compugraphics '92, Lisbon, Portugal, December 1992.

DAVIS, Gregory W., Assistant Professor, Gary L. HODGES, Lieutenant, USN, and Frank C. MADEKA, Captain, USAF, "The Development of a Series Hybrid Electric Vehicle for Near-Term Applications," 28th Intersociety Energy Conversion Engineering Conference, Atlanta, Georgia, 8 August 1993.

JOYCE, James A., Professor, "Shallow Crack Technology and Fracture Toughness," JCCCNRS Working Group 3, St. Petersburg, Moscow, 25 September 1992.

JOYCE, James A., Professor, "Calculation and Interpretation of Results," Committee E24.08.03/04 at ASTM Committee Week, Miami, Florida, 15-18 November 1992.

JOYCE, James A., Professor, "Effects of Tensile Loading on Upper Shelf Fracture Toughness," USNRC Constraint Workshop, USNA, Annapolis, Maryland, 11-12 February 1993.

JOYCE, James A., Professor, "Improved Load Ratio Method for Predicting Crack Length," ASTM Committee Week, Atlanta, Georgia, 19 May 1993.

MADEKA, Frank C., Captain, USAF, Gregory W. DAVIS, Assistant Professor, and Gary L. HODGES, Lieutenant, USN, "U.S. Naval Academy Hybrid Electric Vehicle Challenge: Amphibian '96," Electric Vehicle Association of Greater Washington, DC, 8 December 1992, and SAE Baltimore Section, 18 February 1993.

MORAN, Patrick J., Assistant Professor, "A Study of the Nucleation of Pits on Al-Ta Alloys," Research in Progress Symposium, Corrosion '93, New Orleans, Louisiana, 9 March 1993.

MORAN, Patrick J., Assistant Professor, "Effect of Microstructure on Passive Film Formation and Breakdown of Al-Ta Alloys," Faraday Division of the Royal Society of Chemistry Discussion No. 94 The Liquid-Solid Interface at High Resolution, University of Newcastle upon Tyne, United Kingdom, 7 September 1992.

MORAN, Patrick J., Assistant Professor, "Passivity and Corrosion of Metals and Alloys in Non-Aqueous and Mixed Solvents," Meeting of the Electrochemical Society, Inc., Honolulu, Hawaii, 21 May 1993.

WU, Chih, Professor and Gregory W. DAVIS, Assistant Professor, "Performance of a Geothermal-Heat-Engine-Driven-Air-Conditioning System," International Conference on New Energy Systems and Conversions, Yokohama, Japan, 27 June 1993.

WU, Chih, Professor, "Experimental Design and Analysis of a Brine Valve," 1992 SEM 7th International Congress of Experimental Mechanics, Las Vegas, Nevada, 14-16 July 1992.

WU, Chih, Professor, "Optimum Power Predications for Real Time Combined Cycles," International Conference on Signals and Systems, Geneva, Switzerland, 17-19 June 1992.

WU, Chih, Professor, "Nuclear Powered Gas Turbines," International Conference on Power Systems and Engineering," Vancouver, Canada, 5-7 August 1992.

WU, Chih, Professor, "A Computer Code for the Specific Power Analysis of Thermoelectric OTEC Plants," International Modelling and Simulation Conference, Moscow, Russia, 24-26 September 1992.

WU, Chih, Professor, "Specific Cooling Load of Thermoelectric Coolers," 11th International Conference on Thermoelectrics, Arlington, Texas, 7-9 October 1992.

WU, Chih, Professor, "Solar Collector Analysis for System Simulation," International Conference on Computer Applications in Design Simulation and Analysis, Washington, DC, 10-12 March 1993.

WU, Chih, Professor, "Performance Limit of an Endoreversible Stirling Cycle with Regenerator," 6th International Stirling Engine Conference, Rotterdam, Netherland, 26-28 May 1993.

WU, Chih, Professor, "Performance Limit of a Real Stirling Refrigerator," 6th International Stirling Engine Conference, Rotterdam, Netherland, 26-28 May 1993.

Naval Architecture, Ocean, and Marine Engineering

Associate Professor Marshall L. Nuckols
Chair

The Naval Architecture, Ocean, and Marine Engineering Department conducted scholarly research and professional development rigorously in all three disciplines of this department during the academic year 1992-1993. Faculty members and midshipmen took part in numerous sponsored research activities, including the Trident Scholar Program. A number of faculty members participated in non-funded research and directed senior midshipmen in their research activities, utilizing the excellent laboratory and computer facilities available to this department.

The research chair in Coastal Systems Engineering established last year through sponsorship of the Coastal Systems Station in Panama City, Florida, has been active during the past year. One research project is ongoing and three more have been identified for next year. It is believed that the primary objective of this cooperative research program, that is to provide a direct relationship between the Coastal Systems Station and the U.S. Naval Academy, has been achieved during the first year of the research chair. Subsequent research will be associated with technologies related to diving and salvage, amphibious warfare, special warfare and mine countermeasures.

The department continued to participate actively in professional society meetings and conferences, both nationally and internationally. Research results have been published in journals and other technical publications or presented at national or international seminars. The outcome of the department's deep involvement in research by the civilian and military faculty members is reflected in the academic environment in the classroom for professional and major courses.

Research themes of the department faculty were varied. They include investigations of neutron dosimetry, waves in random seas, separation of heavy metals from soil, corrosion in ship structures, beach profile response, wave barriers, wave runup on large diameter cylinders and composite slopes, nonlinear motion of moored ships, FFG-7 response to beam winds and waves, radioactivity in a marine environment, computer design of small submersible, including propulsion device, stability of tee stiffened plates under combined loads, reliability-centered maintenance, and design development for an advanced producible hull.

Research funding was made available from many sources, including department operating funds, research chairs, and contracts and grants from various research organizations such as the Naval Academy Research Council, the Office of Naval Research, the U.S. Army Corps of Engineers, Naval Facilities Engineering Command, Naval Sea Systems Command, Defense Nuclear Agency, the United States Coast Guard, Coastal Systems Station, the Trident Scholar Program and Lehigh University.

Sponsored Research

An Independent Review of the SOE Development Process

Researcher: Professor Roger H. Compton
Sponsor: Naval Sea Systems Command

The objectives of this project are to perform an independent review of the process currently used to develop a Submerged Operating Envelope (SOE), to assess the level of confidence on the engineering

predictions required, and to recommend improvements in the process.

A panel of independent authorities in the area of submarine maneuvering was convened to perform the technical review. Through a series of interviews with the active participants in the U.S. Navy SOE development process and related technological disciplines, the panel acquired information about the present process.

Wave Groups and Breaking Waves in Random Seas

Researchers: Professor Thomas H. Dawson, Associate Professor
David L. Kriebel, and Louise Wallendorf, Ocean Engineer
Sponsor: Office of Naval Research

Wave groups and wave breaking in random deep-water seas are being studied experimentally using Naval Academy's 380 foot towing tank. Results ate have been compared with theoretical work accounts for non-linear effects on crest amplitudes. This work is continuing under ONR sponsorship with further attention to be directed towards an understanding of the interrelationship between wave breaking and wave groups.

Experimental Evaluation of Air Cyclone Separation Technology for Removal of Heavy Metals from Soil

Researchers: Midshipman 1/C Mark A. Genualdi, USN,
Professor Martin E. Nelson and
Assistant Professor Mark J. Harper
Sponsors: Department of Energy and Naval Facilities Engineering Command

The contamination of soil by plutonium and uranium is a significant problem in areas where nuclear testing is conducted or where a nuclear accident has occurred. To date several methods are being tested worldwide to develop an efficient and economical process for separating these contaminants from soil. Some of these processes involve water, which results in further contamination and production of radioactive liquids. The U.S. Naval Academy has been tasked with examining one possible method for separating the contaminants using a dry method called cyclone elutriation. Two pieces of equipment were studied, and experiments were run at the Naval Academy in hopes of finding the one which could accomplish the goal of obtaining 80% of the heavy metal in 20% of the total volume. The method examined in this project is the rotor-type centrifugal air separator, which separates particles according to differences in density. This system was not developed specifically for the purpose of separating heavy metals from soil but the principle has been shown to work. Several variables were changed throughout the course of the experiments including: rotor blade size, circulating air shutter position, and pre-treatment of the soil by sieving. The surrogate metal (non-radioactive) chosen for testing the effectiveness is bismuth, which is non-toxic, and has a density close to that of plutonium.

A Probabilistic-Based Methodology for Including Corrosion in the Structural Life Assessment of Marine Structures

Researchers: Midshipman 1/C John W. Hopkins, Jr., USN
and Associate Professor Gregory J. White
Sponsor: U.S. Coast Guard

One of the problems in the life assessment analysis of marine structures is the effect of exposure to a corrosive environment on strength and survivability. This problem takes two forms: loss of strength due to wastage of the material, and loss of function due to localized pitting. The research underway in this effort is part of a larger project which attempts to establish a means of quantifying both general wastage and localized pitting of steel plating in a probabilistic format.

In order to use the probabilistic model two parameters which characterize the statistical nature of the corroded surface need to be available. These parameters, called the *sill* and *range of influence*, are derived from a very careful surface mapping of the corroded material.

Because of the extremely large number of data points needed for the surface mapping, a standard means of measuring and recording the surface topology needed to be developed. The major effort in this project was in the design, construction, and testing of an automated *corrosion measurement rig*.

The important parts of the rig are the parallel motion arms and the thickness probe. Both parts are driven by electric stepper motors controlled from a standard personal computer. The parallel motion arms allow the precise positioning of the two thickness probes so that measurements can be made from both sides at the same point. The thickness probes are spring-loaded points which trip an electric switch at a particular displacement. The points are driven in and out on a track system powered by small stepper motors.

SUPERTANK Data Collection Project

Researcher: Associate Professor David L. Kriebel
Sponsor: U.S. Army Corps of Engineers

The SUPERTANK Data Collection Project, sponsored by the Army Corps of Engineers, was conducted during August and September 1991, at the Wave Research laboratory of Oregon State University. The goal of the project was to collect data on nearshore waves and sediment transport under controlled conditions at prototype scale in a large wave tank. Over 30 investigators from the U.S. and several other countries took part in this project. The team from the Naval Academy included Dr. Kriebel from the Ocean Program, Ms Louise Wallendorf from the Engineering Hydromechanics laboratory, and two 1/C Midshipmen. The goal of the Naval Academy team was to measure wave conditions in the nearshore zone from the region near the still water shoreline to the upper limit of wave runup. Preliminary data analysis has been completed and a draft data report has been published.

Convolution Method for Beach Profile Response

Researcher: Associate Professor David L. Kriebel
Sponsor: National Science Foundation

This project involved the development of a simple analytical method to predict the time-dependent beach response to severe hurricanes or extra-tropical storms. In previous work, a numerical model was developed to simulate the beach and dune erosion associated with storm surge and storm

wave attack on the open coast. In the present study, a much simpler method was developed that achieves the same result in simple equation form suitable for hand-calculators and engineering design manuals. In this method, the equilibrium beach response is first estimated under the assumption that the maximum storm conditions are maintained indefinitely. This defines the so-called erosion potential of the beach in terms of six primary variables involving the beach profile geometry, sediment grain size, storm surge elevation, and

breaking wave conditions. The time-dependent beach evolution toward this potential response is then obtained in the form of a convolution integral involving the actual storm surge hydrograph (storm surge water level as a function of time) and an exponential erosion response function. Based on this method, it has been shown that the beach seldom reaches its maximum erosion potential. In general, only a fraction of this potential erosion may actually occur due to the relatively short duration of most storms.

Vertical Wave Barriers

Researcher: Associate Professor David L. Kriebel
Sponsor: National Science Foundation

This project involved both theoretical analysis and laboratory scale model testing of a permeable vertical wave barrier. This work is an outgrowth of independent research projects conducted in the last two years by Midshipmen 1/C Laurie Wood, Troy McClelland, and Eric Thomas, USN. In those studies, model tests were conducted on a 1-to-4 scale model of a vertical slotted wave barrier using regular or harmonic incident waves. In the present study, additional model tests were conducted using irregular waves to simulate more realistic incident wave conditions. A simple hydraulic theory was

then developed to describe the wave transmission past the porous wall and to describe the wave forces imparted to the wall. This theory is based on the one-dimensional equations of continuity, momentum, and energy which describes the flow through the slots of the wave barrier in terms of the incident, reflected, and transmitted waves and in terms of the head loss due to flow constriction and re-expansion. The theoretical model was shown to compare favorably to the laboratory data for both the wave transmission and for the wave force on the wall in both regular and irregular waves.

Nonlinear Wave Runup on Large Diameter Cylinders

Researcher: Associate Professor David L. Kriebel
Sponsor: National Science Foundation

This project involved development of an approximate computational method for predicting the vertical wave runup on large diameter circular cylinders. Large diameter cylinders are used as the basic structural elements for large offshore floating platforms such as semi-submersibles and tension-leg platforms. Wave runup on the vertical columns of these structures is of interest becauseit may lead to wave loading on the platform deck or to wave overtopping of the deck in severe sea states. In this study, several empirical methods were evaluated for

estimating the maximum wave runup. A simple analytical method was then developed which has much wider application than the empirical methods. Unlike existing design methods which rely on massive computer programs, the analytical method developed in this research is expressed in simple equation form and is quite simple to apply. By comparison to existing data, it was shown that this new method can predict runup to within the same order of accuracy as the existing computer codes.

Design of a Thermoelectric Heat Pump for Maintaining a Bubble Dosimeter at Constant Temperature

Researcher: Associate Professor Keith W. Lindler
Sponsor: Naval Surface Warfare Center and Naval Academy Research
Council (ONR)

The U.S. Navy is currently seeking an accurate and convenient method of measuring neutron radiation. One such method currently being investigated at the U.S. Naval Academy is the bubble dosimeter. In a bubble dosimeter, radiation induces small droplets of a superheated liquid to grow into a visible bubble. Radiation dose is then determined by counting the number of bubbles formed. Unfortunately, the sensitivity of the bubble dosimeter increases with temperature. Thus in order to obtain accurate readings, the bubble dosimeter must be maintained at a constant temperature.

A feasibility study has shown that a small battery powered thermoelectric heat pump could be used to maintain the dosimeter at a near constant temperature for environment temperatures ranging from 0°C to 50°C. The main problem is rejecting the heat from the heat pump when operating in the cooling mode. The current study investigates the potential improvement in heat pump performance that can be obtained by cascading two or more heat pumps in series operation.

Wave Runup on Composite Slopes

Researchers: Associate Professors Robert H. Mayer
and David L. Kriebel
Sponsor: U.S. Army Corps of Engineers

This research effort proposed combining the two traditional design approaches such that a relatively simple quadratic equation was obtained. This equation can be solved either analytically or numerically for wave runup on uniform or composite linear beach profiles. Experimental verification of this integrated approach was accomplished in the Coastal Engineering Wave Basin of the USNA Hydromechanics Laboratory. Wave runup was measured for numerous wave forms (combinations of incident wave heights and periods) on 10 different composite-linear beach profiles. The measured runup values compared favorably with the values predicted by the new theoretical equation.

Analysis of Data from the SUPERTANK Project

Researcher: Assistant Professor Sarah Mouring
Sponsor: U.S. Army Corps of Engineers

Performed analysis of experimental data collected in August and September of 1991 by Associate Professor David Kriebel as part of the Supertank Laboratory Data Collection Project. The project focussed on cross-shore hydrodynamic and sediment transport processes and took place in a large wave tank at Oregon State University. It was expected that analyses of experimental data would allow for improvement in numerous numerical simulation models. Specifically, this particular analysis dealt with the wave and sediment transport characteristics in the swash zone. The analysis included major modification of an existing analysis program in order to capture the wave transformation and beach face erosion or accretion. By documenting the beach face erosion and accretion over small time increments, a correlation of this process with the wave transformation data can be found. Due to the

massive amount of data, a CRAY supercomputer at the Waterways Experiment Station in Vicksburg, Mississippi was accessed and used. The analysis of the data has been completed and the tabulated results appear in a technical report on the Supertank Project which has been submitted to the Army Corps of Engineers for approval.

On the Nonlinear Motion of Moored Ships

Researcher: Assistant Professor Sarah Mouring
Sponsor: Naval Facilities Engineering Command

The problems caused by excessive motions of single point moored (SPM) ships are associated with the hawser configuration. These motions can cause the loading on a hawser to exceed the snap load; therefore, such motions are critical to the safety of the mooring. However, ship motions are difficult to predict due to the nonlinearity of the equations of motion. Recently, experimental and theoretical studies of the nonlinear motions of SPM supertankers have been performed by Wichers and de Kat. Since supertanker motions are relatively slow, many of the nonlinear terms in the hydrodynamic force equations were neglected. However, this assumption needs to be verified.

Therefore, the purpose of this study was to determine the sensitivity of the nonlinear motions of a ship to each one of these neglected higher order terms. The nonlinear equations of motion were developed by Professor Michael E. McCormick and the researcher, where all of the nonlinear terms were included. These modified equations have been simultaneously solved by developing a computer program using the computer language, Advanced Continuous Simulation Language (ACSL). Presently, the equations of motion are being applied to both combatant and commercial ships using the computer program.

Beam Wind and Wave Experiments on a FFG-7 Model

Researcher: Professor Bruce C. Nehrling
Sponsors: Naval Sea Systems Command and the
Naval Surface Warfare Center, Carderock Division

A 1:36 scale model of a FFG-7 hull form outfitted with a two dimensional superstructure has been subjected to extremely high wind and wave loadings while tethered to the beam in the Hydromechanics Laboratory's 380 foot long towing tank. The model's transverse stability has been measured along with statistical values of its roll, heave and pitch motions. These experiments were conducted for both the intact condition, at various displacements and vertical centers of gravity, and with significant flooding due to simulated underwater damage. In addition, wind velocities and profiles, as produced by the newly constructed wind generation system, continue to be measured and mapped. This test program is part of a continuing research effort to statistically evaluate the limits of the Navy's current stability criteria.

Investigation of Low Level Radioactivity in a Marine Environment

Researchers: Professor Martin E. Nelson and
Assistant Professor Mark H. Harper
Sponsor: Naval Research Laboratory

The dumping of highly radioactive wastes at sea has been banned worldwide for more than three decades. In April 1993, a team of 46 experts headed by Dr. Aleksei V. Yablokov of the Russian Federation has detailed how the Soviet Union repeatedly broke the rules and dumped vast amounts of highly radioactive wastes, including spent nuclear reactors into the Kara and Barents Seas. The Yablokov report says that the Soviet Union dumped 2.5 million Curies of radioactive wastes, including 18 nuclear reactors from submarines and an icebreaker. In 1992 Norway and Russia began a joint examination of the waters for signs of danger, finding little evidence to prompt immediate concern. But the ship carrying the team was barred from access to the disposal sites themselves. In August 1993, an American-Russian team, prompted by efforts of Alaska's Senator Ted Stevens, will visit some dump sites and collect samples. The Naval Research Laboratory, in conjunction with Wood's Hole Oceanographic Institution and several other government and private agencies is tasked with the post visit analysis of the samples. The researchers and the United States Naval Academy team, will be conducting measurements for alpha and gamma radiation from the samples, and hope to ascertain the presence and concentration of Pb^{210} and other radionuclides that would be present in the location of radioactive waste.

Coastal Systems Research Chair

Researcher: Associate Professor Marshall L. Nuckols
Sponsor: Coastal Systems Station, Panama City, Florida

A Memorandum-of-Understanding between the United States Naval Academy and the Coastal Systems Station (CSS), Panama City, Florida was implemented which describes an agreement for cooperative research related to diving and salvage, amphibious warfare, special warfare, and mine countermeasures. During this first year, one research project involving model testing of various fin/afterbody configurations for submarine designs was conducted in the Hydromechanics Laboratory. Three additional research programs have been identified, plus the continuation of the fin/afterbody project, which will involve four USNA faculty during the summer intersessional.

Statistical Data Analysis and Presentation

Researchers: Midshipman 1/C Brian L. Pilger, USN, and
Assistant Professor Mark J. Harper
Sponsor: Defense Nuclear Agency

The purpose of this research project was to develop methods of data analysis and presentation to support the Trident Scholar Program and Midshipman 1/C Jeremy Rich, USN, trident scholar. Two systems were investigated for use in this project, Stat-Sci and Quattro Pro, both readily available, however, Quattro Pro was selected for use in this project as mainframe power was not needed. Professor Tufte's methods of graphical excellence were used to give accuracy and integrity to the presentation of results. The method developed for statistical data analysis and presentation results was

used effectively to analyze and portray Trident Scholar Program research projects.

Reliability Centered Maintenance

Researcher: Associate Professor Kenneth L. Tuttle
Sponsor: Naval Sea Systems Command

The purpose of this ongoing research project is to develop faculty expertise and a Maintenance Engineering Laboratory at the U.S. Naval Academy for instruction of the Midshipmen in modern maintenance engineering concepts. The objectives are stated as follows: (1) To develop instructional capabilities in maintenance engineering, (2) To introduce RCM, Reliability Centered Maintenance, to Naval Officers, and (3) To develop long range planning for introducing maintenance engineering into the curriculum.

The Diesel Engine Room Laboratory was upgraded to allow operation of the DEMA System on the GM 3-71 Diesel Engine/Generator Set using a personal computer. The IDAX 100 computer was installed to control data acquisition in the DEMA System, monitors alarm conditions, produces sheets, and maintains trend analyses. The IDAX 100 offered some expert system capability, however it had a unique operating system and communication between the IDAX 100 and DOS was difficult. The new PC Interface has made a dramatic improvement in the quality of the instruction being given the midshipmen using the DEMA System. Progress is being made toward the addition of significant new engine monitoring capabilities. A replacement head is being modified to allow measurement of cylinder firing pressures. The Naval Academy has joined the local developer of the DEMA System in developing further Diesel engine monitoring and analysis technology for the U.S. Navy.

An Experimental Investigation into the Structural Stability of the Stiffened Plate Panels Under Combined Loads

Researcher: Associate Professor Gregory J. White
Sponsor: Naval Surface Warfare Center

Provide analytical, design, and experimental test support for an investigation into the structural stability of tee stiffened plate panels subjected to in-plane compressive axial load and lateral pressure load using the test facilities at the U.S. Naval Academy. Analytical and design support will be required to assist in defining the geometry of specimens to rest as well as the combination of in-plane axial and lateral pressure loads to apply. Experimental test support will entail overseeing the tests to be conducted at the Naval Academy and acquisition of test data. Test specimens will be supplied by the sponsor.

Related to Design Development and Joining Methods for Advanced Producible Hull

Researcher: Associate Professor Gregory J. White
Sponsor: Lehigh University

The researcher will participate in the work directed at the Technology Efforts identified as Design and Development and Joining Methods for Advanced Producible Hull. Specifically within these areas the researcher will contribute to the effort on Reliability-Based Studies. This includes work in the

following areas: (1) Identification of analytical and experimental information needed to define component resistance for reliability-based design of advanced hull structural systems, (2) Probabilistic framework for analytical and experimental component resistance evidence and (3) Development of preliminary recommendations for reliability-based design criteria for fatigue.

Investigation of Bubble Dosimeter Suitability for Treaty Verification Applications

Researcher: Midshipman 1/C Jeremy C. Rich, USN
Advisers: Assistant Professor Mark J. Harper and
Professor Martin E. Nelson
Sponsor: Trident Scholar Program and
Defense Nuclear Agency

The objective of this project was to investigate the feasibility of using the bubble dosimeter as an downs of nuclear forces associated with the post-cold war transition, there is an increased demand at this time to develop unobtrusive technology that could be used in the field by inspectors to measure whether the nuclear weapons inspected meet the guidelines delineated by the arms reduction treaties. The Defense Nuclear Agency (DNA) sponsored the project with the hopes that the bubble dosimeter will prove adequate for this purpose.

Although the bubble dosimeter is a rugged device, ideally suited for field work, three problems must be tackled and overcome before use of the dosimeter can be considered feasible. This project focussed upon evaluating and solving the problems of temperature dependence, bubble growth rate and accurate statistical analysis of the data. Extensive theoretical and experimental work was undertaken to design new detectors which would have a response which remained consistent with temperature. Furthermore, extensive experimentation was conducted at USNA's Neutron Generator Facility, with the purpose of evaluating the neutron detection characteristics of the bubble dosimeter.

Development of an Integrated Computer Design Tool

Researcher: Midshipman 1/C Kyle Turco, USN
Sponsor: Trident Scholar Program
Advisers: Lieutenant Commander William A. Davidson, USN,
Professor Bruce Johnson, and Nancy Harris, Naval Architect

This project presents the results of an investigation into the development of an interface system for the design of submersible internal arrangements and hull forms. The research and development were conducted as a Trident Scholar research project at the United States Naval Academy. The design process was founded on what is being called concurrent design methodology. The development of the process involved the interfacing of commercially available geometric modeling and CAD tools with analytical parametric methods for marine vehicle drag analysis. The interfaced design tools were then employed to design a human powered submersible in order to validate the efficiency of the particular concurrent design processes used in this project. The submersible vehicle's design requirements were established by the Bi-annual Human Powered Submarine Race committee. To provide a basis for relative performance comparisons, previously constructed and raced submersibles were remodeled using the systems CAD tools in order to be evaluated and compared, on an equal basis, to the new design generated by this research project. The methods of design and analysis are detailed in this report. The report also contains the new program that was created to extract vehicle hull form characteristics from geometric data. The efforts of this project have shown probable reductions in vehicle drag over existing human powered submersibles.

Independent Research

Investigation of Human-Generated Power Production Underwater

Researcher: Lieutenant Commander William A. Davidson, USN

The Human-Powered Submarine competition is an international event held every two years to foster interest in ocean engineering and underwater systems. Numerous academic institutions, government agencies, and corporations from around the world design, build, and race their submarines. Being a human-powered event, considerable thought must be given to determining possible output production. Ability to determine maximum sustainable cadence and load must be identified for design parameters. Clearly identifying power capabilities will allow for optimizing future hull and drive train designs.

Eight midshipmen divers underwent a wide range of loading and cadence tests on the Academy's underwater ergometer. Data is compiled and tabulated for reference in future designs.

Design of a Minimal Drag Surface Buoy for the Human-Powered Submarine

Researchers: Ensign David Hopkins, USN,
Midshipman 1/C Christopher Beaufait, USN and
Lieutenant Commander William A. Davidson, USN

One of the requirements of the competition is for each submarine to tow a buoy on the surface to serve as a locator for race organizers as they track progress. During the last Human-Powered Submarine competition in 1991, the Naval Academy's SQUID experienced problems with the surface buoy, repeatedly pulling it underwater. This problem became severe enough to cause SQUID to be eliminated from the competition. To avoid this unfortunate occurrence at future events, an investigation was conducted and an optimum shape was designed for future surface buoys. The primary objective of the research was to design a buoy that would create minimal drag and minimize likelihood of being pulled underwater. Five basic shapes were investigated. Each shape was towed through the 120-foot tank, with waves, to simulate ocean conditions. Specific cases of being pulled underwater were recreated. Shape and tow-line attachment point locations were changed in an effort to overcome this effect. Concurrently, drag readings were obtained for each configuration. The final result was a buoy shape with a sharper nose able to better cut through a wave and present less surface area to be pushed underwater.

Reactants for Deep Submergible Vehicles

Researcher: Associate Professor Kenneth L. Tuttle

The purpose of this research has been to compare reactants that have been identified for use in closed-loop, submerged heat engines. Small submarines used at great depths are severely limited in power plant operation. Mostly, batteries are used; however, fuel cells, nuclear fission, external combustion engines, and internal combustion engines are also possible and have been tried successfully. Almost every conventional device used to convert stored energy to shaft power has been modified to power a deep submergence vehicle.

Recent efforts have been directed toward

developing internal and external combustion engines to operate closed-loop in deep submergence vehicles. The reactants, both fuel and oxidizer, must be carried aboard the submarine, although liquid fuels can be placed outside the pressure vessel. The products of combustion must be discharged overboard or stored. The hydrogen component of a hydrocarbon produces water during combustion as does hydrogen fuel. Water in the products of combustion is not a problem as it can be condensed and easily stored or pumped overboard. Carbon bearing fuels, including all hydrocarbons, produce carbon dioxide during combustion. The carbon dioxide is more difficult either to store or to discharge. The remaining objective is to indicate problems and advantages associated with each available heat engine; however, the main objective, which has been completed, was to show calculated results for thirteen combinations of potential reactants.

Research Course Projects

Ocean winds and Rolling of the MCM-1 Avenger Class Minesweeper

Researcher: Midshipman 1/C Keng S. Chong USN
Adviser: Professor Roger H. Compton

With the advent of more sophisticated analytical and experimental techniques, the naval architect is systematically upgrading ship design methods developed in the slide rule era. One such method concerns the U.S. Navy's statics-based transverse stability criterion for a ship experiencing extreme beam winds and waves. Two U.S. Navy experimental hydromechanics facilities--one, the Carderock Division, Naval Surface Warfare Center (CD-NSWC), and the other, the U.S. Naval Academy Hydromechanics Laboratory (NAHL)-- have recently developed experimental systems to expose ship models to a dynamic beam wind and wave environment. While the goal of both systems are the same, the hardware configurations and testing procedures are different at each facility.

The objective of the present research project was to conduct experiments in the 380 foot Towing Tank at the NAHL and compare CD-NSWC results with those found. Appropriately scaled beam winds and waves were then created to cause the model to heel to one side and roll about the resulting non-zero heel angle.

From the results of the NAHL experiments, it is shown that the NAHL facility and experimental techniques were able to produce experimental heel angles that correlated well with CD-NSWC results.

Bi-Directional Wave Energy Conversion Turbine

Researcher: Midshipman 1/C Bryan M. Cochran, USN
Adviser: Professor Michael E. McCormick

An experimental study of a bi-directional radial turbine used in wave energy conversion. The turbine was mounted on a pneumatic capture chamber, and the system was tested in the 380-foot wave tank. An electrical generator (d.c.) was excited by the turbine, and produced a maximum quasi-steady voltage of about 15 watts. Several gearing combinations were tried, as were a number of electrical line resistances. The design of the system appears to be ideal for remote communities, such as the Naval Base at Diego Garcia.

The Design and Construction of a Towed Camera Sled for the BLUEY

Researcher: Midshipman 1/C Peter A. Corrao, Jr., USN
Adviser: Associate Professor Marshall L. Nuckols

The objective of this research was to design, build and test a prototype camera sled to be used in conjunction with the Oceanography Department's Research Ocean Vehicle and the yard Patrol Craft YP686. All objectives were accomplished in this independent research project except open water testing, which has been deferred to a later date.

Theoretical Evaluation of Air Cyclone Separation Technology for Removal of Heavy Metals from Soil

Researcher: Midshipman 1/C Heath L. Hanshaw, USN
Adviser: Professor Martin E. Nelson, and
Assistant Professor Mark J. Harper

A theoretical analysis of the applicability of the DUCON separator to heavy metal separation from soil was conducted. This was done in conjunction with physical experiments being conducted at the United States Naval Academy as to the effectiveness of two types of mechanical separators, the DUCON and the SEPOR. First, a fluid model was developed incorporating pump and fan data, minor losses, and cyclone separator losses to predict air velocities in the entrainment chamber. Predictions with a 2 HP motor and constant speed fan are that a maximum velocity (globe valve fully open) of 1.41 feet per second will be achieved. Deviations from this model are predicted to be due to pressure leaks in the system.

Second, an analysis of elutriation at various velocities was conducted. This was done using a code developed by DUCON inputting the air viscosity, density, and velocity and particle size distribution and density and outputting the maximum entrainment particle size, maximum entrainment rate, and entrained particle size distribution. Results were heavily dependent on source of soil and type and source of particle size analysis used. The best results predicted on a single feed were to separate 72% of the test surrogate Bismuth into 21% of the Soil. The most realistic prediction will entrain 93% of the Plutonium into 34% of the soil. These predictions raise hopes that the separator may prove economically viable as a means of environmental restoration.

Third, the effectiveness of electron microscope analysis of experimental output was examined. It was determined that the electron microscope could be used to observe particle size separation but that it could not be used to determine the amount of heavy metal separation obtained.

Ducon Entrainment Testing

Researchers: Midshipman 1/C Aaron J. Miles, USN
Professor Martin E. Nelson and
Assistant Professor Mark J. Harper

The Ducon entrainment system is used to investigate physical separation techniques to separate heavy metals from soils. The underlying operational principle is the density and particle size differences between the soil and the heavy metal. The actual testing is being performed with Bismuth, which has been chosen because of similar physical properties to Uranium and Plutonium.

The project goal was to attain an 80% reduction of the heavy metal contaminant in the soil. A test plan has been developed, which is studying the effect of feed rate, air flow rate, and particle size.

System parameters such as velocity profiles and pressure drops have also been measured. The test plan has not been completed because of operational problems that have developed with the system.

Modifications to the systems have been performed to correct these problems. It is expected that further testing will continue shortly.

The Design of Low Power, Low RPM, Large Diameter Propellers

Researchers: Midshipmen 1/C Andrew D. Schmidt and
David R. Smullen, USN
Adviser: Professor Roger H. Compton

The design of a propeller for a unique marine vehicle like a human powered submarine presents the naval architect with a problem which is outside the normal range of standard marine propeller design methods. A combination of first principles and designs of ultra-light aircraft propellers was used to estimate the propeller design parameters. Current Computer Aided Design (CAD) techniques were employed to draw the blade. The CAD files created became the input to the Computer Aided Manufacturing (CAM) process. A small scale blade model was produced.

Temperature Effects on the Haldanian Decompression Algorithm

Researcher: Midshipman 1/C Jeffrey M. Scott, USN
Adviser: Associate Professor Marshall L. Nuckols

Haldanian theory suggests that the uptake of inert gas is dependent only on the blood/tissue interface areas, tissue resistance to perfusion, and the difference in inert pressure between blood and tissue. Defining these tissue characteristics by a Half-life, and fixing a maximum tissue partial pressure for each Half-life empirically, is overly simplistic. Haldanian theory, and the Half-life method, assumes inert gas uptake is dependent only on the partial pressure of the inert gas and time. What the theory does not account for is the body's ability to change its peripheral vascular resistance in response to many stimuli, including temperature. The change in perfusion affects the rate of inert gas exchange by changing the blood/tissue interface area.

Another entirely neglected factor in Haldanian theory is the change in rate of inert gas diffusion across a membrane as temperature changes. Experiments were performed in an attempt to determine this change quantitatively, but the results were inconclusive. Instead, a linear variation between temperature and diffusion rates is assumed and applied to a standard Haldanian algorithm. While the linear assumption is not an answer to the effect of temperature on inert gas behavior, it is a step towards the development of a more accurate model of the human body in a high pressure environment.

Wave Runup on Curvilinear Beach

Researchers: Midshipmen 1/C Gregory E. Selfridge, and
Mark A. Vannoy, USN
Advisers: Associate Professor David L. Kriebel and
Associate Professor Robert H. Mayer

The researchers first designed and constructed an artificial beach cross-section in the Coastal Engineering Wave Basin of the USNA Hydromechanics Laboratory. The beach consisted of a linear sloping beach face above the still water level and a concave-upward curvilinear beach profile

below the still water level that simulated natural beach geometries. Experimental testing involved twenty combinations of wave height and period, along with six different combinations of water level and beach-face slope. In each of these 120 tests, wave runup was measured along with incident wave conditions. These measured runup values were then compared to values predicted by the new theoretical model. In general, the new method was found to be highly effective at describing the wave runup for these complicated but realistic curvilinear beaches and additional work is planned making use of random waves.

An Experimental Study of the NAVSEA Prismatic Planing Boat Series Seakeeping Characteristics

Researcher: Midshipman 1/C Kevin Stroud, USN
Adviser: Professor Roger H. Compton

Side-by-side testing of the three hulls of the NAVSEA prismatic planing boat series (two at a time) in irregular, long crested head seas for their vertical acceleration (at CG) and added resistance due to waves responses was performed in the 380-foot towing tank at the Naval Academy Hydromechanics Laboratory. Three discrete speeds and two NATO sea state conditions were investigated. The experimental results were compared with the well-known regression method of Savitsky and Ward-Brown.

A Systematic Study of Calm Water Performance of U.S. Navy Pontoon Barges

Researcher: Midshipman 1/C Andrew F. Ulak, USN
Adviser: Professor Roger H. Compton

Towing tank tests were performed on three models of Navy pontoon barges, commonly used as causeway sections in amphibious operations. The goal of these tests was to determine the effects of varying the hull geometry and loading on the total resistance of the barges. This research was suggested by the Naval Civil Engineering Laboratory, the tests were conducted in the Naval Academy Hydromechanics Laboratory.

Publications

CERZA, Martin R., Assistant Professor, co-author, "The Influence of Pool Circulation on Natural Convection and Pool Boiling of R113 from a Vertical Array of Tubes," *Proceedings* of the sixth International Symposium on Transport Phenomena in Thermal Engineering, Pacific Center of Thermal Engineering, I (1993), 99-104.

This paper reports the effect of pool circulation on the natural convection and pool boiling of R113 from a vertical array of horizontal tubes. Tests were conducted with increasing and decreasing heat flux. The pool circulation with respect to the heated tube array could be either in an upward or downward direction depending on whether the circulation was driven by natural convection from the heated tube array or by the circulation induced by the nucleating auxiliary heaters, respectively. The heat flux range of the heated tubes was 250 to 100,000 W/m². Pool circulation was determined to have a significant effect on the natural heat transfer coefficients from the heated tube array and no

effect on the boiling heat transfer coefficients.

COMPTON, Roger H., Professor, John J. ZSELECZKY, Naval Architect, and Ensign William S. ABRAMS, USN, "Underway Inclining Experiments Performed on a Planing Hull Model," *Proceedings* of the Intersociety High Performance Marine Vehicle Conference (HPMV'92), Arlington, Virginia, 1992, pp. PC104-PC116.

The overall transverse stability of planing boats at post-hump speeds is investigated using a 1:8 model of a current U.S. Coast Guard hull. The results of a series of tests in which static heeling moments were applied to the moving model which was free to heel, trim, and rise (or sink) are presented and discussed. Experimental techniques are described and data are compared to available related results.
The results of this experiment show that the equilibrium conditions change as ship speed, heeling (righting) moment, and the center of gravity position change.

COMPTON, Roger H., Professor, and James J. SHAUGHNESSY, Naval Architect, "SWATH (TAGOS-19) Ruddelizer Loading In Irregular Waves: An Experimental Study," Division of Engineering and Weapons Report EW-13-92, June 1992.

A novel aspect of a novel new ship type, the Small Waterplane Area Twin Hull (SWATH) ship, is the inclined after control surface used for both steering and vertical motion control called the "ruddelizer." It's novel configuration raises questions about the magnitudes of seaway-induced structural loadings which the ruddelizer is likely to experience. Conventional design practices for rudders and horizontal control surfaces (sail planes, bow planes, and stern planes) for submarines are related, but not similar enough to use with confidence for SWATH ruddelizer design. A large model of T-AGOS 19 was prepared for testing in irregular waves. An extensive test series involving three sea states, eight ship-to-wave headings, and four ruddelizer deflection angles was undertaken. For all tests, the model was at zero speed and free in all six degrees of freedom.

COMPTON, Roger H., Professor, John J. ZSELECZKY, Naval Architect, and Bruce C. NEHRLING, Professor, "Side-by-side Testing of Hard Chine and Round Bilge Semiplaning Models in Waves," *Proceedings* of the Intersociety High

Performance Marine Vehicle Conference (HPMV'92), Arlington, Virginia, June 1992, pp. PC60-PC71.

Two patrol craft models, with similar length-to-beam ratios, displacement-to-length ratios, and pitch gyradii, were instrumented to measure pitch motion, heave motion, and vertical accelerations at three longitudinal locations. One model had hard chines, while the other one had round bilges. Tests were run at three speeds in both regular and irregular long-crested head seas, with the models arranged side-by-side, so that they encountered the waves simultaneously. The seakeeping motions and accelerations of the two models are compared and the merits of side-by-side model testing are discussed.

COMPTON, Roger H., Professor, and Bruce C. NEHRLING, Professor, "The Performance of a Systematic Series of Ice-Capable Hull Forms in Open Water," *Transactions of the Society of Naval Architects and Marine Engineers*, 100 (October 1992), pp. 223-270.

As part of the continuing Trident Scholar Program at the United States Naval Academy (USNA), a systematically varied series of ice-capable bow forms fitted to a common stern were designed and tested to characterize each hull's open water performance. Testing was completed in calm water for bare hull effective horsepower performance and in head seas for pitch, heave, added resistance due to waves, and relative bow motion performance. Flow visualization studies of the forebodies were conducted.
In addition, performance in ice was estimated for each hull form using current empirical methods. The paper also presents analytic estimates of open water performance characteristics using such tools as SMP, standard series EHP estimates, and the ADDRESS code for added resistance in waves. The results of these predictions are compared to the measured model data to provide a measure of the effectiveness of these tools in analyzing these "extreme" hull forms. The results also allow the examination of open water performance degradation which might occur in each of these areas (seakeeping, calm water EHP, and added resistance in waves) with varying levels of icebreaking capability. Finally, various voyage scenarios are played out to determine how the tradeoffs between open water and ice capabilities might affect the selection of hull form for a particular mission.

NAVAL ARCHITECTURE, OCEAN, AND MARINE ENGINEERING

HARPER, Mark J., Assistant Professor, "Calculation of Recoil Ion Effective Track Lengths in Neutron-Radiation-Induced Nucleation," *Nuclear Science and Engineering*, June 1993, pp. 118-123.

A theoretical model was developed to predict the amount of nucleation that occurs as a result of neutron interactions in superheated liquids. The model utilizes nuclear cross section data, charged particle linear energy transfer (LET) information, and computations of critical bubble nucleation energy to generate the number of bubbles formed in superheated liquid droplet ("bubble") neutron detectors exposed to neutron fluxes of specified intensity and energy. Previous experimental attempts to relate effective (energy-depositing) ion track length L to critical bubble radius r_c using a dimensionless coefficient were unsuccessful. This paper proposes the formulation of a new coefficient b, equal to the ratio of effective ion track length L to the seed bubble radius r_o. By parametrizing the in todel, the least-squares best value of b was determined to be 4.3 for both high and low energy californium-252 neutrons. Thus the effective recoil ion track length in radiation-induced nucleation can be determined if the seed bubble radius is known.

KRIEBEL, David L., Associate Professor, and Thomas H. DAWSON, Professor, "Distribution of Crest Amplitudes in Severe Seas with Breaking," *Journal of Offshore Mechanics and Arctic Engineering*, 115, (1993), 9-15.

A theoretical model is presented for the probability distribution of wave crest amplitudes in severe seas states with wave breaking. As the severity of a sea state increases, nonlinearities cause an increase in the amplitudes of the largest wave crests with a subsequent modification of the distribution of wave crest amplitudes from the linear Rayleigh theory. In this paper, a theory for the probabilities of these nonlinear crest amplitudes is first reviewed based on earlier work. The further limitations on these nonlinear crest amplitudes by wave breaking are then considered. As a result, a theoretical model is presented to account for both: (1) the nonlinear increase in the highest wave crests, and (2) the selective reduction of some fraction of these high crests due to wave breaking. This model is then verified using several sets of laboratory data for severe breaking seas having approximate JONSWAP wave spectra.

KRIEBEL, David L., Associate Professor,

"Convolution Method for Time-Dependent Beach Profile Response," *Journal of Waterway, Port, Coastal, and Ocean Engineering*, ASCE, 119, 2, (March 1993), 204-226.

A simple analytical solution is presented for approximating the time-dependent beach-profile response to severe storms. This solution is in the form of a convolution integral involving a time-varying erosion-forcing function and an exponential erosion-response function. The erosion-forcing function reflects changes in the nearshore water level and breaking wave height. In this paper, an idealized storm-surge hydrograph is considered from which an analytic solution is obtained for beach and dune erosion associated with severe storms such as hurricanes or northeasters. It is shown that for a given initial beach geometry and sediment size, the peak water level and the incipient breaking wave height determine the maximum erosion potential that would be achieved if the beach were allowed to respond to equilibrium. Because of the assumed exponential erosion rate, beach response obtained from the convolution method is found to lag the erosion forcing in time, and is damped relative to the maximum erosion potential such that only a fraction of the equilibrium response actually occurs.

KRIEBEL, David L., Associate Professor, "Nonlinear Wave Runup on Large Circular Cylinders," *Proceedings* of Fifth Civil Engineering in the Oceans Conference, College Station, Texas, November 1992, pp. 173-187.

Various design methods for computing nonlinear wave runup on a large-diameter circular cylinder are presented. First, empirical correlations are developed between the observed maximum wave runup and the incident wave and cylinder properties. Then, a simple theoretical method is developed for obtaining design estimates of the maximum runup. This method is based on the well-known linear diffraction theory and on the assumption that higher-order harmonic components of a nonlinear wave can be treated as if they were linear waves in order to estimate their individual runup contribution. It is then shown that these simplified methods can predict the measured runup with an accuracy comparable to more computationally intensive second-order diffraction methods.

KRIEBEL, David L., Associate Professor, co-author, "Broadside Current forces on Ships,"

Proceedings of Fifth Civil Engineering in the Oceans Conference, College Station, Texas, November 1992, pp. 326-340.

A method of estimating the static lateral current force on ships in deep and finite depth water is presented for the case of the current broadside to the ship. The method is based on recent scale model studies conducted, together with re-analysis of data for a wide variety of vessels modeled over the past five decades at a number of laboratories. In the method a deepwater drag coefficient is determined from ship properties. The shallow water limiting drag coefficient is determined as a function of current velocity squared. Drag coefficients for a vessel in finite depth water are then determined from a power law interpolation. A key finding is that channel blockage biases results from most laboratory studies.

LINDLER, Keith W., Associate Professor, "Design and Testing of a Thermoelectric Heat Pump for Temperature Control of a Bubble Dosimeter," *Proceedings* of the 27th Intersociety Energy Conversion Engineering Conference, San Diego, California, August 1992.

In a bubble dosimeter, radiation induces small droplets of a superheated liquid to grow into a visible bubble. Radiation dose is then determined by counting the number of bubbles formed. Unfortunately, the sensitivity of the bubble dosimeter increases with temperature. Thus in order to obtain accurate readings, the bubble dosimeter must be maintained at a constant temperature.

A feasibility study has shown that a small battery powered thermoelectric heat pump could be used to maintain the dosimeter at a near constant temperature for environment temperatures ranging from 0°C to 50°C. The current study deals with the design and optimization of the thermoelectric heat pump system. A small prototype heat pump has been constructed for proof of concept and to validate a computer spreadsheet model that was developed for system optimization. This paper describes the design of the prototype heat pump and presents the results of performance tests conducted with the prototype.

LINDLER, Keith W., Associate Professor, "Computer Spreadsheet Modeling of a Thermoelectric Heat Pump," *Proceedings* of the Summer Computer Simulation Conference, Reno,

Nevada, July 1992, pp. 547-551.

In a bubble dosimeter, radiation induces small droplets of a superheated liquid to grow into a visible bubble. Radiation dose is then determined by counting the number of bubbles formed. Unfortunately, the sensitivity of the bubble dosimeter increases with temperature. Thus in order to obtain accurate readings, the bubble dosimeter must be maintained at a constant temperature.

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MAYER, Robert H., Associate Professor, co-author, "Decision Making Methodology for Design of Subsea Line Structures," *Proceedings* of Oceans '92 (IEEE), Newport, Rhode Island, 28 October 1992, pp. 180-185.

Among the decisions facing the designer of subsea line structures such as cables and pipelines are the route, size and type (of pipeline or cable), method of installation and the means of protection. Each of these decisions can significantly effect both system cost and reliability. Combined with the uncertainties associated with offshore environmental conditions and manmade hazards, the designer of such systems is presented a complex decision problem.

Described herein is a decision analysis model which considers all typical interdependent design variables and inherent uncertainties "simultaneously." Combined with the estimates of costs, benefits, and potential consequences of the various design alternatives the methodology facilitates selection of the most acceptable system design. This techno-economic approach has been developed into a detailed model with accompanying software to aid designers in selecting economic designs of subsea line structures while achieving acceptable levels of reliability.

MAYER, Robert H., Associate Professor, and Michael E. MCCORMICK, Professor, "A Cost-Effective Design Study of a Near-Shore Pneumatic Wave Energy Conversion System," *Proceedings* of MTS '92, The Annual Meeting & Technical Conference of the Marine Technology Society, Washington DC, 19 October 1992, pp. 81-86.

A conceptual design of a near-shore pneumatic wave energy conversion system is presented. The system is designed to operate in 2-to-4 meters of water, where most swell are shallow water waves. In shallow water the wave height rapidly increases as the wave shoals which is, then, accompanied by a substantial increase in the potential energy of the wave. The potential energy is that which is needed for efficient conversion by pneumatic wave energy conversion systems. Also, design in shallow water reduces both structural and energy transmission costs. Finally, shallow water operation enhances the shore-protection capability of the wave energy converter, thereby giving the system a dual function: power conversion and coastal protection. It is shown that an application of such a system in the coastal waters off the Mid-Atlantic United States will produce busbar electrical power at approximately $3,000/kW (or $0.075/kW-Hr), which makes the system quite competitive.

MAYER, Robert H., Associate Professor, "A Floating Pier of Recycled Plastic: A Unique O/E Design Experience," Engineering & Weapons Report EW-14-92, June 1992.

In compliance with recent environmental legislation, Naval ships are being outfitted to stow plastic wastes for disposal in port. Much of these plastic wastes are recyclable and have been converted into structural members similar to lumber. Picnic tables, park benches and car stops are examples of products currently being fabricated of recycled plastic.

When it became necessary to replace a floating timber pier at the Robert Crown Sailing Center during the summer 1991, consideration was given to designing and constructing the replacement pier of recycled plastic. Accordingly, the Naval Systems Engineering Department chose to use this potential project as a design opportunity for midshipmen majoring in ocean engineering. Two teams of midshipmen (three members each) were tasked with the design of a floating pier of recycled plastic which would satisfy both the operational requirements of the Sailing Center and the

structural requirements of the material.

MCCORMICK, Michael E., Professor, Robert H. MAYER, Associate Professor, and Louise A. WALLENDORF, Instructor, "A Jack-Up Semi-Submersible for UCT Operations," Engineering and Weapons Report: EW-02-92, January 1993.

A conceptual design of a transportable, jack-up semi-submersible platform is presented. The design is modular, can be transported by conventional means, and can be assembled by UCT personnel with the aid of a 10-ton hydraulic crane (or equivalent). The design satisfies two operational conditions: (1) that the platform be sufficiently stable to allow at-sea construction and repair operations in a state 4 sea; and, (2) that it be able to survive in a state 6 sea. Wave tank tests, using a 1/24th scale model, suggest that both criteria should be well satisfied by the full-scale prototype.

MCCORMICK, Michael E., Professor, co-author, "A Cost-Effective Design Study of a Near-Shore Pneumatic Wave Energy Conversion System," *Proceedings* of MTS '92, The Annual Meeting & Technical Conference of the Marine Technology Society, Washington DC, 19 October 1992, pp. 81-86.

A conceptual design of a near-shore pneumatic wave energy conversion system is presented. The system is designed to operate in 2-to-4 meters of water, where most swell are shallow water waves. In shallow water the wave height rapidly increases as the wave shoals which is, then, accompanied by a substantial increase in the potential energy of the wave. The potential energy is that which is needed for efficient conversion by pneumatic wave energy conversion systems. Also, design in shallow water reduces both structural and energy transmission costs. Finally, shallow water operation enhances the shore-protection capability of the wave energy converter, thereby giving the system a dual function: power conversion and coastal protection. It is shown that an application of such a system in the coastal waters off the Mid-Atlantic United States will produce busbar electrical power at approximately $3,000/kW and $0.075/kW-Hr, which makes the system quite competitive.

MCCORMICK, Michael E., Professor and Robert H. MAYER, Associate Professor, "An Experimental Study of a Bidirectional Radial Turbine for Pneumatic Wave Energy Conversion," *Proceedings*

Oceans '92, Institute of Electrical and Electronic Engineers, Newport Rhode Island, October 1992, pp. 866-870.

Results of a wave tank study of the performance of a vertical pneumatic wave energy conversion system using a bidirectional radial turbine are presented. The system consists of a vertically oriented 1.4-meter diameter capture chamber which houses an oscillating water column with a down-facing mouth. Water enters and exits through the mouth with the passage of each wave. The vertically oscillating water column acts as a piston, alternately driving the air above the column out through the turbine and drawing air in through the turbine. The turbine, in turn, excites a d-c generator. In this study, both regular and random waves were used.

The efficiency of the system compared well with results from an earlier study of the same capture chamber using a bidirectional counter-rotating axial turbine. The peak efficiency is approximately 35%, depending on the wave conditions and the submergence of the mouth. Results obtained using the axial turbine were slightly better than 36% with the same conditions. The advantage in the radial turbine is in the simplicity of design and construction. The system tested supplied approximately 90 Watts of d-c electrical power when operating in a regular wave having a wave height of approximately 0.35 meter and a period of approximately 2.4 seconds. The system is ideal for supplying electrical power to fixed navigation aids.

MCCORMICK, Michael E., Professor, co-author, "Decision Theory Modeling of Iceberg Dynamics," Engineering and Weapons Report EW-12-92, June 1992

Among the decisions facing the designer of subsea cable systems are the cable route, cable size and type, method of protection and the installation plan. Each of these decisions can significantly affect both system cost and reliability. Combined with the uncertainties associated with offshore environmental conditions and man-made hazards, the cable system designer is presented a complex decision problem.

Decision theory is a powerful tool for optimizing the design of systems dealing with uncertainties. Proposed herein is a decision analysis framework which considers all the interdependent cable system design variables and inherent uncertainties simultaneously. Combined with estimates of the costs, benefits, and potential consequences of the various design alternatives, the methodology facilitates selection of the most acceptable cable system design. If appropriate, this techno-economic approach may be developed into a detailed model with accompanying software which can aid designers in selecting economic subsea cable system designs while achieving acceptable reliability levels.

MOURING, Sarah E. Assistant Professor, co-author, "Criteria for Minimizing Floor Vibration Caused by Building Occupants," *Proceedings* of International Colloquium on Structural Serviceability of Buildings, CIB/IABSE, Goteborg, Sweden, June 1993, pp. 125-132.

One major serviceability consideration in modern building construction is excessive floor vibrations due to occupant activities. Methods for accurate prediction of these vibrations and evaluation of floor systems are not readily available to the design community. An investigation is made into the characteristics of crowd-induced loads. The load characteristics are incorporated into simplified but realistic load models. Analytical procedures are developed to determine the influence of each load characteristic on the dynamic response of floor systems. Design guidelines are developed for floor systems subjected to crowd-induced loads.

NELSON, Martin E., Professor, and Mark J. HARPER, Assistant Professor, "Experimental Verification of a Superheated Liquid Droplet (Bubble) Detector Theoretical Model," Radiation Protection Dosimetry, Spring, 1993, pp.

Superheated liquid droplet ("bubble") neutron detectors utilize thousands of microscopic droplets of freon-based compounds, suspended in a viscous matrix material. Neutrons can interact with the atoms of the superheated liquid droplets, resulting in the formation of energetic charged recoil ions. These ions transfer their energy to the liquid in the droplets, sometimes resulting in the droplets vaporizing and producing visible bubbles. The basis of bubble detector operation is identical to that of bubble chambers. Each of the microscopic superheated liquid droplets behaves like an independent bubble chamber. This paper presents a theoretical model that considers the three principal aspects of detector operation: nuclear reactions, charged particle energy deposition, and thermodynamic bubble formation.

NUCKOLS, MARSHALL L., Associate Professor, "Project SEA-GOAT 360: An Exercise in ROV

Design," *Proceedings* of Underwater Intervention '93, New Orleans, Louisiana, 18-21 January 1993, pp. 79-84.

In the Spring semester of 1992, a select group of Ocean Engineering students at the U.S. Naval Academy designed, built, and tested a low-cost remotely-operated vehicle as a class project. The project was designed to help the students gain hands-on experience in an actual engineering environment and to give them a chance to apply some of the knowledge gained in the classroom. The mission objectives, including an inspection capability at 200-foot depth, were selected to challenge the students technical abilities while making the project achievable within one semester.

The project was an unconditional success, bringing rave reviews from the students stating the positive experience such a hands-on project adds to their understanding of ROV design. Future plans for the vehicle include further development by other ocean engineering students to refine and expand its capabilities.

TUTTLE, Kenneth L., Associate Professor, "Marine Engineering Design I," *Proceedings* of the The American Society for Engineering Education (ASEE) Annual Conference, Toledo, Ohio, 24 June 1992, pp. 1913-1916.

The U.S. Naval Academy created Marine Engineering Design I and added the course to the curriculum. This course includes the use of computers in design--both for calculations as well as drawing and machining. Design I introduces the design process to Marine Engineering majors; the course is used to introduce Computer Aided Design and Computer Aided Machining. The design project involves the design of a Spur Gear Tooth and the associated Reduction Gear Set. Students use the CADIG facility, Computer Aided Design and Interactive Graphics, to draw the shape of one half of the tooth they design. CADIG has in-house software named Quick-Draw, QWIKDR, and various ThreeD programs on a VAX 11/780 and eight Evans and Sutherland PS300's using the UNIX Operating System. Students design and draw half of a tooth and then use in-house software to turn the half tooth into a whole tooth and add the third dimension. The single tooth is multiplied to produce a three dimensional pinion. The project includes taking a copy of one tooth to the shop and have the computer controlled milling machine cut the shape of the tooth on a brass name plate which

is also designed and drawn by the student using CAD/CAM.

TUTTLE, Kenneth L., Associate Professor. "Reactants for Deep Submergence Vehicles," *Ocean Engineering*, 19, 5, (October 1992), 479-487.

Small submarines used at great depths are severely limited in power plant operation. Mostly, batteries are used; however, fuel cells, nuclear fission, external combustion engines, and internal combustion engines are also possible and have been tried successfully. Almost every conventional device used to convert stored energy to shaft power has been modified to power a deep submergence vehicle. This research compares reactants that have been identified for use in closed-loop, submerged heat engines by calculating the amount of reactant needed for a two day voyage. The objective is to show calculated results for thirteen combinations of potential reactants. Eleven different fuels and two different oxidizers were included. Using an overall thermodynamic efficiency of 26.5 percent, an engine on each fuel produces an average power of 20 kilowatts for 48 hours on station plus power for six hours to descend 6000 meters and six hours to ascend.

WHITE, Gregory J., Associate Professor, "Fatigue of Ship Structural Details: A Probabilistic Approach for Design," Engineering and Weapons Report No. EW-01-93, January 1993.

The purpose of this report was to provide the background and explanation of a reliability-based design procedure for assessing the fatigue capacity of ship structural details. This work was part of a larger effort undertaken at the ATLSS Laboratory of Lehigh University to look at the fatigue characteristics of different weld types on different materials. In order for the information coming from that research to be useful to the ship designer, it was felt that a computer program implementing a probabilistic fatigue design procedure should be developed.

Because of the extensive amount of research and work which have gone into this field in the last decade, the effort in this report is aimed at assessing the available methodologies and synthesizing their most suitable parts into a computer implementation of a reliability-based design method.

WHITE, Gregory J., Associate Professor, co-author,

"Uncertainties in Resistance and Strength Measures of Marine Structures," *Proceedings* of the Second International Symposium on Uncertainty Modeling and Analysis (ISUMA), University of Maryland, College Park, Maryland, 25-28 April 1993, pp.

Reliability-based design is becoming an increasingly important area of development in marine structures. In order to develop reliability-based design formats for marine structures the uncertainties associated with the strength side of the various limit-states need to be investigated. In this paper, a methodology is presented for quantifying the uncertainty in the strength measures and the analytical models used in the design of marine structures. Existing design codes in other fields of engineering are reviewed for limit-state expressions and measures of uncertainty in modeling.

Presentations

CERZA, Martin R., Assistant Professor, "The Influence of Pool Circulation on Natural Convection and Pool Boiling of R113 from a Vertical Array of Tubes," The Sixth International Symposium on Transport Phenomena in Thermal Engineering, Seoul, Korea, 9-13 May 1993.

COMPTON, Roger, H., Professor, "An Independent Review of the SOE Development Process," Naval Sea Systems Command, Washington, DC, 29 May 1993.

COMPTON, Roger H., Professor, John J. ZSELECZKY, Naval Architect, and Ensign William S. ABRAMS, USN, "Underway Inclining Experiments Performed on a Planing Hull Model," The Intersociety High Performance Marine Vehicle Conference (HPMV'92), Arlington, Virginia, 24-27 June 1992.

COMPTON, Roger H., Professor, John J. ZSELECZKY, Naval Architect, and Bruce C. NEHRLING, Professor, "Side-by-side Testing of Hard Chine and Round Bilge Semiplaning Models in Waves," the Intersociety High Performance Marine Vehicle Conference (HPMV'92), Arlington, Virginia, 24-27 June 1992.

COMPTON, Roger H., Professor, and Bruce C. NEHRLING, Professor, "The Performance of a Systematic Series of Ice-Capable Hull Forms in Open Water," Annual Meeting of the Society of Naval Architects and Marine Engineers, New York, New York, 29 October 1992.

COMPTON, Roger H., Professor, "Our Society 100 Years Ago," Chesapeake Section of the Society of Naval Architects and Marine Engineers, Arlington,

Virginia, 17 November 1992.

HARPER, Mark J., Assistant Professor, "Experimental Verification of a Superheated Liquid Droplet (Bubble) Detector Theoretical Model," Tenth International Solid State Dosimetry Conference, Washington, DC, 17 July 1992.

HARPER, Mark J., Assistant Professor, "Superheated Liquid Droplet Neutron Detectors, A Theoretical Examination," Naval Surface Warfare Center Colloquium, Armed Forces Radiobiology Research Institute (AFRRI), 10 July 1992.

HARPER, Mark J., Assistant Professor, and Martin E. NELSON, Professor, "Removal of Radioactive and Other Heavy Metals from Soil," Department of Energy (Nevada Field Office and Office of Technology Development), U.S. Naval Academy, Annapolis, Maryland, 6-8 April 1993.

HARPER, Mark J., Assistant Professor and Martin E. NELSON, Professor, "Bubble Neutron Detector Applications for Nuclear Weapons Treaty Verification Purposes," Defense Nuclear Agency, and the Center for Verification Research, U.S. Naval Academy, Annapolis, Maryland, 20 October 1992, 25 March 1993, and 20 April 1993.

HARPER, Mark J., Assistant Professor, and Martin E. NELSON, Professor, "Separation of Heavy Metals from Soil Using Air Cyclone and Elutriation Techniques," American Nuclear Society Annual Conference, San Diego, California, 24 June 1993.

KRIEBEL, David L., Associate Professor, "Vertical Wave Barriers: Wave Transmission and Wave Forces," The Twenty-third International Conference

on Coastal Engineering, Venice, Italy, 9 October 1992.

KRIEBEL, David L., Associate Professor and Ensign Brian L. DAVIES, USN, "Model Testing of Wave Transmission Past Reef Breakwaters," The twenty-third International Conference on Coastal Engineering, Venice, Italy, 9 October 1992.

KRIEBEL, David L., Associate Professor, "Nonlinear Wave Runup on Large Circular Cylinders," Fifth Civil Engineering in the Oceans Conference, College Station, Texas, 10 November 1992.

LINDLER, Keith W., Associate Professor, "A Thermoelectric Heat Pump Used for Temperature Control of a Bubble Dosimeter," Superheated Drop Bubble Dosimetry Applications Workshop, Armed Forces Radiobiology Research Institute, Bethesda, Maryland, 10 July 1992.

LINDLER, Keith W., Associate Professor, "Computer Spreadsheet Modeling of a Thermoelectric Heat Pump," SCS Summer Computer Simulation Conference, Reno, Nevada, 27-30 July 1992.

LINDLER, Keith W., Associate Professor, "Design and Testing of a Thermoelectric Heat Pump for Temperature Control of a Bubble Dosimeter," Twenty-seventh Intersociety Energy Conversion Engineering Conference, San Diego, California, 2-7 August 1992.

MAYER, Robert H., Associate Professor, "Decision-Making Methodology for Design of Subsea Line Structures," The 1992 IEEE Conference - Occars '92, Newport, Rhode Island, 28 October 1992.

MAYER, Robert H., Associate Professor, "A Cost-

Effective Design Study of a Near-Shore Pneumatic Wave Energy Conversion System," MTS '92, the Annual Meeting & Technical Conference of the Marine Technology Society, Washington, DC, 28 October 1992.

MAYER, Robert H., Associate Professor, "A Floating Pier of Recycled Plastic: A Unique Design and Construction Experience," a joint Mechanical Engineering/Naval Architecture, Ocean and Marine Engineering Department seminar at the United States Naval Academy, 30 September 1992.

MAYER, Robert H., Associate Professor, "A Floating Pier of Recycled Plastic: A Unique O/E Design Experience," American Society of Engineering Education, Annual Conference, Toledo, Ohio, 22 June 1992.

MOURING, Sarah E., Assistant Professor, "Criteria for Minimizing Floor Vibration Caused by Building Occupants," International Colloquium on Structural Serviceability of Buildings, CIB/IABSE, Goteborg, Sweden, 10 June 1993.

NUCKOLS, Marshall L., Associate Professor, "Project SEA-Goat 360: An Exercise in ROV Design," Underwater Intervention '93, New Orleans, Louisiana, 19 January 1993.

TUTTLE, Kenneth L., Associate Professor, "Marine Engineering Design I," American Society for Engineering Education, Annual Conference, Toledo, Ohio, 24 June 1992.

WHITE, Gregory J., Associate Professor, co-presentor, "Uncertainties in Resistance and Strength Measures of Marine Structures," Second International Symposium on Uncertainty Modeling and Analysis (ISUMA), University of Maryland, College Park, Maryland, 25-28 April 1993.

Hydromechanics Laboratory

Professor Roger H. Compton
Director

The primary functions of the Naval Academy Hydromechanics Laboratory (NAHL) are to support education and research in ship hydromechanics and ocean engineering. The facilities which constitute the NAHL are:

(1) 380 Foot Towing Tank (380'x26'x16') - This premier facility features two towing carriages and a servo-controlled, electrohydraulically activated, dual flap wavemaker. Both towed and self-powered ship models can be tested in calm water, regular waves, and irregular waves. All waves generated are long-crested. A modular wind generation system capable of producing scale winds exceeding 100 knots is available. Open water propeller characteristics can be determined by means of a propeller boat. Maneuvering characteristics can be evaluated by means of a large amplitude, horizontal planar motions mechanism. Most testing is done at model speeds up to 25 fps, but special tests have been run at speeds as high as 48 fps. Surface ship and submarine models can be tested. A drydock and finger pier located at the North End of the basin can be isolated from the main tank by means of closeable drydock doors.

(2) 120 Foot Towing Tank (120'x8'x5.5') - Ship models up to about 6 feet in length can be towed in calm water, regular waves, and irregular waves. Long-crested waves can be generated by a wavemaker which is effectively a 1/3 scale model of the wavemaker in the 380 foot towing tank. Both deep and shallow water experiments are run in this facility. The tank can be configured with a false bottom to simulate various shoaling water conditions. The capability to do wind testing is planned due to the modular nature of the 380 foot tank system. The powered carriage can attain speeds as high as 13 fps. The tank is also equipped to perform gravity tow (constant force) mode testing.

(3) Coastal Engineering Tank (52'x48'x2') - This L-shaped tank is equipped with a piston-type wavemaker and a moveable bridge for positioning wave probes. Small scale breakwaters, groins, jetties, and harbor arrangements can be studied with respect to wave reflection, refraction, transmission, and absorption properties. Wave guides allow the basin to be subdivided for multiple experimental setups. A small circular wave tank can be erected within the main tank to study wave induced littoral transport phenomena.

(4) Circulating Water Channel (Test Section 5'x1.3'x1.3') - This small, free-surface water channel with a top speed of 12 fps is used primarily for flow visualization around control surface models and cavitating propeller models. Quantitative measurements of hydrodynamic forces on rudders and hydrofoils have also been made. The channel can be pressurized from +6 psig to -12 psig to adjust model cavitation numbers.

(5) Computer Workstations - A number of Hewlett-Packard and Gateway 486 PC workstations are available for midshipman, staff, and faculty use to acquire and analyze measured data and to define hull shapes using the FASTSHIP program. The capability exists to use the FASTSHIP offset files to cut hull models on a numerically-controlled milling machine located adjacent to the NAHL.

(6) Stability/Ballast Tank (24'x12'x3.5') - This tank is used to investigate the hydrostatic stability characteristics of ship models--inclining experiments and righting arm experiments--as well as being used to ballast models in preparation for testing in the 380 foot or the 120 foot towing tanks.

All of the operating facilities are electronically linked via a local network to a host computer located in the control room for the 380 foot tank. The host computer not only permits speed and consistency in data acquisition and analysis from all facilities, but is integral to the control and sequencing of experimental hardware used in testing.

The NAHL Staff is a small, multi-talented group which plans, sets-up, performs, and interprets the measured data from experimental programs undertaken for midshipmen, faculty, and certain outside governmental agencies. The staff of 9 consists of 5 graduate engineers/naval architects, 3 engineering technicians, and a office manager/secretary. Liaison with the Naval Academy faculty is maintained by an appointed Laboratory Director who is also a member of the teaching faculty.

Notable facilities improvements begun or completed during the current reporting period include: (1) the laboratory's host computer system has been received, and is in active service; (2) calibration and initial use of a wind generating system for the 380 foot tank have been accomplished by the laboratory staff; and (3) installation, outfitting and active use of a computer workstation/observation module for the low speed carriage in the 380 foot towing tank were accomplished by the laboratory staff.

Academic programs continue to reflect the benefits of the Laboratory's participation in significant research efforts for the Army, Navy, Coast Guard, and the National Science Foundation. Programs have included: (1) Physical modelling of a current USN combatant ship in beam winds and waves in both intact and damaged conditions for NAVSEA; (2) Study of analytical, experimental, and full scale methods to predict submarine responses to extreme maneuvers for NAVSEA;

(3) Submarine series testing of tail cone/control surface configuration variations for CSS; (4) Hovering submarine dynamics due to waves in restricted water depths for CSS; (5) Support of SUPERTANK project of Army Corps of Engineering; (6) Nonlinear wave phenomena for ONR; (7) Ocean wave group characteristics studies; (8) SWATH T-AGOS-19 control surface loads for NAVSEA; and (9) Appendage effects on icebreaker roll damping for USCG.

Experimental research studies with intense midshipmen involvement have included the following: (1) Wave runup on curvilinear beaches; (2) Beam wind and wave testing of intact MCM and FFG models; (3) NAVSEA planing boat series testing in calm water and irregular head seas (side-by-side); (4) Testing of systematic barge series in calm water; (5) Acoustic mapping of turbulent jet flow; (6) Wave energy conversion experimentation; and (7) Laboratory support of TRIDENT Scholar Research Program.

Publications

SCOTT, David M., Ensign, USN, "Still Water Performance of a Series of Hard Chine Prismatic Planing Hulls," U.S. Naval Academy, Division of Engineering and Weapons Report EW-11-93, June 1993.

The effects of changing deadrise on the resistance and running trim of planing boats is investigated using three geometrically similar models. The results of a series of calm water tests in which moving models were free to rise and trim are presented and discussed. Experimental techniques are described and data are compared to standard analytical prediction methods.

The results of this experiment show that increasing deadrise increases the ship's horsepower requirements and running trim at any given speed. It is also shown that present experimental results and standard analytical predictions do not correlate consistently with each other.

WALLENDORF, Louise A., Ocean Engineer, co-author, "Breaking Waves in Laboratory-Generated JONSWAP Seas," *Applied Ocean Research*, Essex, England: Elsevier Science Publishers Ltd, 15 (1993), 85-93.

Results from a laboratory study of wave breaking in deep-water random seas are presented for approximate JONSWAP sea states. Waves generated at one end of a 116-meter wave tank are observed for breaking at a section of the tank approximately 30 meters from the wavemaker and in regions spanning three and six meters about the section. Emphasis is on the relative number of breaking waves observed at the section and in the regions about it, and on the relative number of crest amplitudes exceeding specified levels at the section. Measurements at the section are shown to be in good agreement with predictions formed using idealized assumptions about the breaking waves and modified Rayleigh distribution of crest amplitudes that accounts approximately for nonlinear effects in seas with narrow-banded wave frequencies. Results indicate that the average downward crest acceleration of breaking waves in these sea states is equal approximately to one-third the acceleration of gravity. Experimental measurements of breaking in regions about the section are shown to be in good agreement with theoretical predictions relating breaking events over a region to those at a fixed location.

ZSELECZKY, John J., Naval Architect, "The New Facilities, Techniques, Ice Testing, and Validation Committee Report," *Proceedings* of the Twenty-Third American Towing Tank Conference, 11-12 June 1992, pp.237-242.

The "New Facilities and Techniques" Committee was expanded for this year's conference to include Ice Testing and Validation. In past conferences, "Ice Testing" work has been represented in a separate session. This year however, the schedule of the ATTC overlapped with two ice-related conferences that were expected to keep most ice-tankery experts from participating. The subject "Validation" has also been added to the committee to ensure that all subjects covered by the ITTC are represented by the ATTC. "Validation" refers to the validation of theoretical and numerical models of marine hydrodynamics.

A brief summary of new facilities and major equipment put into service since the last ATTC is listed below. Detailed descriptions of these facilities can be found in the "Written Contributions" section of this report, and/or in the published papers for the session. Some of the written contributions have been edited to fit within the available space.

ZSELECZKY, John J., Naval Architect, NEHRLING, Bruce C., Professor, COMPTON, Roger H., Professor, "Side-by-Side Testing of Hard Chine and Round Bilge Semiplaning Models in Waves," *Proceedings* of the Intersociety High Performance Marine Vehicle Conference (HPMV'92), Arlington, Virginia, June 1992, pp.PC60-PC71.

Two patrol craft models, with similar length-to-beam ratios, displacement-to-length ratios, and pitch gyradii, were instrumented to measure pitch motion, heave motion, and vertical accelerations at three longitudinal locations. One model had hard chines, while the other one had round bilges. Test were run at three speeds in both regular and irregular long crested head seas, with the models arranged side-by-side, so that they encountered the waves simultaneously. The seakeeping motions and accelerations of the two models are compared and the merits of side-by-side model testing are discussed.

ZSELECZKY, John J., Naval Architect, co-author, "Experimental Determination of Nonlinearities in Vertical Plane Ship Motions," *Proceedings* of The Nineteenth Symposium on Naval Hydrodynamics, Seoul, Korea, August 1992, pp.53-70.

Experiments have been conducted in regular and random waves of varying severity (steepness) on a model of a standard hull form. Variation of the heave and pitch transfer functions, as wave steepness was varied, indicate a nonlinear motion behavior for this hull. The response has been modelled as a Volterra functional expansion carried out to include quadratic and cubic terms. The higher order kernels of the expansion have been determined from the regular wave data and have been confirmed by polyspectral analysis of random wave data. The results show how the usual assumption of linearity of response can lead to incorrect predictions, and also show the effect of non-Gaussian random behavior in both the input (waves) and the responses.

Presentations

ZSELECZKY, John J., Naval Architect, "The New Facilities, Techniques, Ice Testing and Validation Committee Report," The Twenty-Third American Towing Tank Conference, New Orleans, 12 June 1992.

ZSELECZKY, John J., Naval Architect, co-author, "Side-by-Side Testing of Hard Chine and Round Bilge Semiplaning Models in Waves," Intersociety

High Performance Marine Vehicle Conference (HPMV'92), Arlington, Virginia, 24 June 1992.

ZSELECZKY, John J., Naval Architect, co-authors, "Experimental Determination of Nonlinearities in Vertical Plane Ship Motions," The Nineteenth Symposium on Naval Hydrodynamics, Seoul, Korea, 24 August 1992.

Weapons and Systems Engineering

Professor E. Eugene Mitchell
Chair

Research within the Weapons and Systems Engineering Department continues to provide the faculty with an opportunity to grow professionally and to keep abreast of rapidly advancing systems technology. In addition, every graduating Systems Engineering major participates in independent research, design, and development projects for the purpose of realizing practical application of some of the theory which they have studied.

Every faculty member, both civilian and military, either participates in independent research in areas of interest to the U.S. Navy or supports midshipmen research programs in an advisory capacity. Faculty research areas include gun system dynamics and fire control, neural networks, turbine modeling and control, composite materials, pattern recognition for medical diagnostics, and fuzzy logic applications in control.

This year there were four Trident Scholars in the Systems Engineering Department. They engaged in extensive research projects in lieu of several courses,

and produced publishable results. Their research topics include robotic stereo vision, neural network application to fault diagnosis, gas turbine control, and optical fiber strain gage development.

Strong emphasis continues on the faculty - midshipman relationship during the student independent research course. Each midshipman is assigned both an administrative and a technical advisor. These advisors not only provide support of a technical nature, but also emphasize planning, scheduling, and effective oral and written presentation. Typical examples of midshipmen research projects include a walking robot, remote controlled vehicles, line following vehicles, vibration analysis, magnetic levitation, inverted pendulum, light tracker, and wall climber.

Funding for research continues to be diverse. This year sponsors included the Naval Academy Research Council, the Office of Naval Research, and the Naval Surface Warfare Centers at Carderock and at Dahlgren.

Sponsored Research

Dynamic Model of Phalanx Gun Mount

Researcher: Associate Professor Thomas E. Bechert
Sponsor: Naval Surface Warfare Center, Dahlgren and Naval Academy
Research Council (ONR)

The Phalanx Close-in Weapon System (CIWS) includes a gatling-type machine gun mounted on a frame which rotates on bearings about an elevation axis. The bearings, in turn, are supported by a frame which rotates about an azimuth axis. Servo motors rotate both gun support frames about their axes to direct the gun to the desired orientation. The objective of this project was to develop equations of motion for the gun mount. The equations of motion have been derived for the three

degrees of freedom, including not only the elevation and azimuth axes, but also the rotation of the gatling gun about its axis, to permit investigation of the gyroscopic effects of its rotation on the other axes. Very general assumptions were made regarding the asymmetry of the structures. Lagrangian dynamic methods were used to develop the equations. Computer programs were developed to permit the rapid computation of moments and products of inertia of the system components for

inclusion in the simulations. A preliminary dynamic simulation program was developed; it displayed mount motion with a maneuvering target.

Application of Neural Networks to Acoustic Data Analysis

Researcher: Assistant Professor William I. Clement
Sponsor: Naval Surface Weapons Center, Cardcrock and Naval Academy Research Council (ONR)

Target strength measurement trials are conducted for the purpose of characterizing and modeling a ship's noise radiation pattern, strength, and source. Such trials are composed of as many as 400 runs during which about 5 minutes of time-domain data from each of 250 hull-mounted accelerometers is collected and recorded. Such volumes of data make real-time analysis impossible. Even the task of verifying the data validity (i.e., looking for inoperative sensors) cannot be conducted at the time of the trial. Without some real-time analysis techniques, it is difficult to determine whether certain runs were carried out sufficiently or whether they need to be re-done.

As a first step in the implementation of a real-time analysis system, data validity must be performed. This problem is complicated by the fact that there are a variety of "normal" conditions -- for example, background noise, shaker noise, and explosive shot noise. In addition, different sensors react differently to excitation so there is further variety in what is termed "normal." Such variety, combined with the volumes of data, suggest that a neural network solution may be best. Neural networks have the ability to accurately categorize data with nonlinear feature-space discriminants. Additionally, multi-modal pattern classes are also correctly classified by neural networks. This means that even if the data for one pattern class is distributed in several areas, these will be accurately grouped by the neural network.

A neural network solution is investigated for applicability to the data validity problem. The aim is to train a multi-layer, feed-forward neural network to categorize data as either valid or invalid. Further, if the data is valid, the network will attempt to discern the current noise conditions -- background, shaker, or shot noise. Real-time or near real-time operation is the goal.

The back-propagation neural network performed with 100% accuracy on data from the single platform on which it was trained.

Phalanx Gun Fire Control

Researcher: Professor Robert DeMoyer, Jr.
Sponsor: Naval Surface Warfare Center, Dahlgren and Naval Academy
Research Council (ONR)

The Navy is engaged in a redesign of the Phalanx Gun System. An important part of the redesign is an update of the fore control algorithm. A continual review of the state target estimator software with a special emphasis on the spectral characteristics of the data is the primary task addressed during our current effort.

Statespace Control of an ICR Gas Turbine Engine

Researchers: Professor Terrence E. Dwan, Associate Professor Jerry W. Watts and
Midshipman 1/C Karl f. Prigge, USN
Sponsor: Naval Surface Weapons Center, Cardcrock

The power plant for the electric drive naval ships of the future will be a recuperated, intercooled,

variable-area-turbine-nozzle gas turbine engine. The controller for this engine will be a computer using possibly statespace methods with several modes. A modular simulation computer model of this engine has been developed in ACSL (high level simulation language) and a statespace controller developed using the software MATLAB. There are four modes to the controller: (1) normal operation; (2) overtemp of the turbine inlet temperature; (3) overspeed of the free power turbine; and (4) high idle, add load.

Close-In Weapon System
Robotic Autoloader Feasibility Study

Researcher: Professor Kenneth A. Knowles
Sponsor: Naval Academy Research Council (ONR) and
Naval Surface Warfare Center, Dahlgren

The Close-In Weapons System (CIWS) is intended primarily to provide a limited sector, quick reaction, automatically activated, anti-missile capability for use on virtually every surface naval vessel. The system consists of a self-contained high-speed moving platform containing a high rate-of-fire (approximately 3000 rounds-per-minute) multi-barrel 20 mm gun, an integral ready magazine of ammunition, and a radar detector and guidance module. The small capacity (approximately 900 round) of the ready magazine, coupled with the high rate-rate-of-fire of the gun system, requires frequent magazine reloading. Because of the design of the magazine feed system, reloading is required after any use, since live ammunition becomes exposed to possible electromagnetic emission induced autoignition. The required hand reloading procedure is not only difficult and time consuming, but can only be done after a 30-minute cooldown period following any firing evolutions, and then (by safety requirements), only after securing all electromagnetic emissions (radar, etc.). To overcome these drawbacks, the Navy has been considering the addition of a possible robotic autoloader to the CIWS. After extensive study of the current CIWS and its operations, it was determined that a separate robotic autoloader for the current system was not practical. Instead, an autoloading capability could be incorporated into the CIWS by replacing the current gun and ready magazine portion of the system with an replaceable encapsulated pod consisting of a similar high rate-of-fire gun integrated with a ready load of ammunition, similar to the Mk 4 aviation gun pods, which have been operational for years. Such a pod would be inherently shielded against electromagnetic radiation effects, could be changed out rapidly by an automatic system, and would provide immediate replacement for a jammed gun event as well as for off-line ammunition replenishment. It could also be sized to meet the current CIWS space requirements.

A Neural Network Applied to Magnetic Silencing of Ship Hulls

Researchers: Associate Professor Jerry W. Watts, Assistant Professor William I. Clement and
Midshipman 1/C James A. Delaroderic, USN
Sponsor: Naval Surface Weapons Center, Carderock

The determination of degaussing currents through triaxially oriented degaussing coils to counter onboard magnetization is a problem with mine-sweepers and all naval vessels. The present research uses onboard sensors, some inside the hull and some outside to predict these necessary coil currents. The problem is complicated because of the varying induced magnetization of the ship's hull at various orientations to the earth's magnetic field, which also varies with longitude and latitude. In addition there is an unknown permanent magnetization of the hull, and unknown magnetizations of ship   ment such as motors, generators, and curr.   ng wires. A neural network is being appl.   this problem with a good bit of success. The results will be compared

to other methods of determining coil currents.

Eye Tracking Video Camera System for Acquisition of Bulbar Conjunctiva Images

Researcher: Assistant Professor Carl E. Wick
Sponsor: Naval Academy Research Council (ONR)

The objective of this project is to investigate the feasibility of an eye tracking system that employs a miniature infrared sensitive television camera as the principal data gathering device. A state of the art PC computer image processor is also being investigated for its ability to process and analyze image data in near real-time. A system using these components will be constructed to track eye motion for the purpose of obtaining stabilized images of the blood vessels contained in the conjunctiva of the eye. The initial objectives of this research have been achieved. It was demonstrated that the necessary reflections for a Purkinje tracker could be obtained using a specially built apparatus. The research will now continue in the development of image analysis software to determine eye position.

Stereoscopic Vision System with Applications to Automated Docking and Tracking

Researcher: Midshipman 1/C Michael M. Hsu, USN
Adviser: Assistant Professor William I. Clement
Sponsor: Trident Scholar Program

Of current interest to NASA is the development of an automated docking system to facilitate autonomous operations in space. Such a system would necessarily require that relative position, velocity, and orientation of the two bodies be controlled. Furthermore, in order for such a sy to be able to aid in the recovery of a variet objects--many of which are small and incapable of being active control elements in the docking evolution--the sensory and control equipment must be housed in a single unit. Of utmost importance in the solution to the autonomous docking problem is the rapid acquisition of accurate position, orientation, and velocity measures upon which control actions can be based. Such an autonomous docking system is the subject of this research. The research will focus on the use of stereoscopic vision since it provides a means of resolving smaller objects and distinguishing fine features (as opposed to the use of active means, such as radar).

Applications of Neural Networks in Fault Diagnosis of Rotating Machines

Researcher: Midshipman 1/C William O. Nash, USN
Adviser: Assistant Professor William I. Clement
Sponsor: Trident Scholar Program

Fault diagnosis of industrial processes has been a problem that has concerned manufacturers for years. The problem of fault detection and analysis has been approached in many different ways but has never been solved. Today, neural networks appear to provide a means of solution. Neural networks attempt to simulate the processes in the human brain. They learn from data presented to them and can make judgements based upon this acquired knowledge. This research focuses on the development of a neural network capable of detecting and classifying incipient faults in a rotating machine. The importance of incipient fault detection lies in the cost savings which would result

from early detection and preventive maintenance.

Design of a State Space Controller for an Advanced Gas Turbine Engine

Researcher: Midshipman 1/C Karl F. Prigge, USN
Adviser: Professor Terrence E. Dwan and Associate Professor Jerry W. Watts
Sponsor: Trident Scholar Project

A computer model of an advanced gas turbine engine is nearly completed. (The modeling work is being done by Richard Garman of DTRC and Jerry Watts of USNA.) The engine being modeled is the ICR (intercooled, regenerated) gas turbine engine which will drive future naval ships. There is also an Integrated Electric Drive program which will use this ICR engine to drive electric generators which drive the ship and supply auxiliary power. The contract to build several prototype engines has recently been awarded to Westinghouse (subcontractor Rolls-Royce). Besides two heat exchanges (a regenerator and an intercooler) the engine also features two spools in the gas generator and variable stator vanes in the free power turbine. The variable stator vanes will help with some transients and also provide improved efficiency at part power. At cruise speed with one engine driving each propeller, the engines are operating at about half power. It will be necessary to develop a fuel control and a stator vane control for this computer model. A combination of classical and state space control will be used for this task. Furthermore, the controller will probably be multi-mode for the various operating conditions which the advanced gas turbine will see. This Trident project will develop at least one state space controller possibly with several operating modes to control fuel flow, variable free power turbine stator vanes, and other quantities in the advanced gas turbine engine proposed for future naval service. Curves showing transient response characteristics will be obtained for all feasible transients including cropload and full power add load.

Delamination in Composite Materials Using the Optical Fiber Strain Gage

Researcher: Midshipman 1/C Glen E. Sabin, USN
Adviser: Associate Professor Olaf N. Rask
Sponsor: Trident Scholar Program

The resarcher considered the various causes of delamination in fiberglass/epoxy material and decided to use transverse tensile strain to delaminate layered fiberglass epoxy specimens. Elliptical specimens were instrumented with a fiber optic strain gage. He changed the gage configuration from Mach-Zehnder to Michelson and found a marked improvement in fringe visability due to the polarization properties in the Michelson. A typical output for gross delaminations and for subsequent micro delaminations was found.

Independent Research

Fuzzy Logic Control of a Balance Beam

Researcher: Midshipman 1/C Jay E. Dryer, USN and
Professor E. Eugene Mitchell

Fuzzy logic control has been shown to be an effective control method for some problems. The purpose of this project was to describe how Fuzzy Logic was implemented to solve a particular control problem. The system to be controlled was a simple balance beam that contained a series of linear potentiometers to determine the position of a rolling ball. The objective of the controller was to move the ball to a designed position as quickly as possible with no overshoot.

Another purpose of this project was to show that a Fuzzy Logic controller can be easily built and that it can handle more than one combination of sensor inputs to produce the desired results. Two different methods of providing sensor input was tested. The first experiment used ball velocity and beam angle as inputs to the Fuzzy Logic procedure. The second experiment used ball position and velocity to provide the needed inputs.

Gyroscopic Stabilization of a Radio-Controlled Helicopter

Researcher: Midshipman 1/C John C. Neidigh, USN and
Assistant Professor William I. Clement

Helicopters are inherently unstable craft. As part of the U.S Naval Academy's participation in the International Aerial Robotics Contest to be held in Atlanta, Georgia in June 1993, a gyroscopic stabilization system is being designed and built. The system components include a vertical gyroscope (i.e., a gyroscope with a pendulous mass), optical angular measurement sensors for aircraft attitude determination, and a single-board computer to process the information. The system must intercept the PWM signals being sent to the aircraft servo-motors and adjust them in accordance with the aircraft's attitude. Controller sensitivity is a critical issue, as the helicopter's instability can be exacerbated through an incorrect choice of controller gains. These gains will be set through experimentation. Initially, the stabilizer will be given zero authority. Then, with the helicopter airborne (with human operator), a remote signal will adjust the gains and aircraft performance monitored. The final controller gains will be stored in onboard memory (and later down-loaded to a computer for storage).

Fuzzy Logic Control of a Rotary Inverted Pendulum

Researcher: Midshipman 1/C Stephen O. Sprague, USN and
Professor E. Eugene Mitchell

This paper analyzes the design and function of a rotary inverted pendulum managed by a fuzzy logic controller. The inverted pendulum brings a free-swinging arm to a stable upright position given an initial condition of at rest and hanging vertically downward. The fuzzy logic controller serves as a model-free estimator; however, a mathematical model does aid the engineer in regards to

simulation and the ensuing system analysis. Given a design of the rotary inverted pendulum, Lagrange's equations of motion for non-conservative motion provided a means for deriving a mathematical model of the system. Both the physical pendulum and fuzzy controller were modeled and analyzed in SIMULINK with the aid of MATLAB. These software tools help view the system performance from the perspective of angular position and angular speed, rectangular position and speed in the swinging plane, and angular position and angular speed in a three dimensional control plane. An actual working system was built and tested in the lab to perform in accordance with the initial goal of holding the arm in a stable upright position. However, the design of the system leaves room for further tests in the lab to be paralleled by analysis on SIMULINK and MATLAB. Physical aspects of the rotary inverted pendulum may be changed to give an adaptive fuzzy control the opportunity to 'learn' the solution. A second free-swinging arm may be attached opposite the first, so that the controller must hold two indirectly coupled arms upright.

A Model Based Approach to the Detection and Tracking of Microvessels in Bulbar Conjunctiva Images

Researcher: Assistant Professor Carl E. Wick

Medical researchers have found convincing evidence the topography of the body's smallest blood vessels change in the presence of certain diseases. The same researchers believe that detecting these long term changes may lead to an earlier diagnosis. This investigation is an attempt to find methods that will enable automated blood vessel data recovery from images of the conjunctiva, or "white of the eye." A comprehensive model of the image process has been undertaken and completed. The mathematical model has allowed the construction of algorithms that will reliably detect blood vessels in photographs. Additional work has been completed in using image intensity data to measure the diameters of vessels seen in the image, and to determine their depth within the conjunctiva membrane. Current work is progressing in determining algorithms that will link blood vessel segments found through the detection process. This research is in direct support of dissertation work done through the George Washington University.

Design Course Projects

Each Systems Engineering major enrolls in ES402, Systems Engineering Design, during senior year. This course is the capstone of the Systems Engineering curriculum. The student is required to propose, design, construct, test, demonstrate, and evaluate a system of particular personal or general professional interest.

The ES402 design course requires the combined effort of the total Systems Engineering Department faculty. Military instructors normally function as project monitors and help with organization, administration, and scheduling of individual projects. Civilian faculty function as technical advisors, and military and civilian technicians supply the hands-on technical help.

Associate Professors Robert S. Reed and Professor Kenneth A. Knowles provided the course coordination and administrative effort, and were assisted by Associate Professors Thomas E. Bechert, C. George Brockus, Olaf N. Rask and Jerry W. Watts, and by Professors Robert DeMoyer, Terrence E. Dwan, and E. Eugene Mitchell, who provided technical and systems design assistance and expertise for the listed design projects.

The results of academic year 1992-1993:

WEAPONS AND SYSTEMS ENGINEERING

Fingerprint Recognition
Midshipman 1/C Justin P. Andrews, USN
Adviser: Lieutenant Commander Stephen J. Anthony, USN

Oscilloscope-Computer Interface
Midshipman 1/C David H. Ashby, USN
Adviser: Lieutenant Commander Richard L. Weston, USN

Systems Ball Cart Competition
Midshipmen 1/C Kevin L. Austin
and Julie A Pelton, USN
Adviser: Lieutenant Commander Richard L. Weston, USN

Eigen 500
Midshipman 1/C Joseph W. Bartish, USN
Adviser: Captain Charles B. McClelland, USMC

Force Multiplier
Midshipmen 1/C John A. Bayless
and Michael S. Krot, USN
Adviser: Lieutenant Commander William H. Campbell, USN

Miniature Mars Rover
Midshipmen 1/C Christopher S. Beaufait
and Kelly A. Eubanks, USN
Adviser: Lieutenant Richard L. Weston, USN

Portable Target Motion Computer
Midshipman 1/C Robert M. Berryman, USN
Adviser: Lieutenant Commander Robert A. Shafer, USN

Acoustic Torpedo
Midshipman 1/C Damian H. Bridges, USN
Adviser: Lieutenant Commander Stephen J. Anthony, USN

SAE Walking Machine Project
Midshipmen 1/C Benjamin J. Brown,
Andrew D. Danko, Gregory M. Fallon,
Maureen E. Odell, Jason L. Pike,
Todd D. Vandegrift, Matthew H. Welsh,
and Beauregard M. White, USN
Adviser: Associate Professor Robert S. Reed

Weather Station
Midshipman 1/C Marcello D. Caceres, USN
Adviser: Lieutenant Stephen A. Modzelewski, USN

Security Camera
Midshipman 1/C Scott N. Callaham, USN
Adviser: Lieutenant Commander Michael K. Johns, USN

Systems Ball Cart Competition
Midshipmen 1/C Marc G. Carlson, Michael P. Joyner,
and Thomas H. Muldrow, USN
Adviser: Captain Scott J. Fuller, USMC

Systems Ball Cart Competition
Midshipmen 1/C Mark G. Carter,
and Philip L. Engle, USN
Adviser: Lieutenant Commander Richard L. Weston, USN

Eigen 500
Midshipmen 1/C Michael A. Cesta,
and Michael J. Sobkowski, USN
Adviser: Lieutenant William B. Taylor, USN

Inverted Pendulum Control
Midshipman 1/C Tarek S. Chbeir, USN
Adviser: Lieutenant Robert A. Shafer, USN

Path Remembering Car
Midshipman 1/C Christopher J. Chilbert, USN
Adviser: Captain Scott J. Fuller, USMC

Eigen 500
Midshipmen 1/C Earl W. Checkley
and Troy A. Solberg, USN
Adviser: Lieutenant Peter S. Allison, USN

Eigen 500
Midshipman 1/C Michael M. Cho, USN
Adviser: Captain Scott J. Fuller, USMC

Handicapped Computer Interface
Midshipman 1/C James D. Collier, USN
Adviser: Lieutenant Commander Michael K. Johns, USN

Magnetic Levitation
Midshipmen 1/C James D. Deen
and Bruce F. Robinson, USN
Adviser: Lieutenant Commander Stephen J. Anthony, USN

Eigen 500
Midshipmen 1/C Efren O. Delacruz
and Michael T. Spencer, USN
Adviser: Lieutenant Stephen C. Lanier, USN

Neural Net Magnetic Silencing
Midshipman 1/C James A. Delaroderie, USN
Adviser: Lieutenant Stephen A. Modzelewski, USN

The Quadruped
Midshipman 1/C Travis B. Done, USN
Adviser: Captain Donald S. Smith, USMC

WEAPONS AND SYSTEMS ENGINEERING

Eigen 500
Midshipmen 1/C Carlton T. Elliott
and Jay A. Murphy, USN
Adviser: Lieutenant William B. Taylor, USN

Dynamic Balancing
Midshipman 1/C Harold H. Ellsworth, USN
Adviser: Captain Donald S. Smith, USMC

Computer Mapper
Midshipman 1/C Jorge R. Flores, USN
Adviser: Lieutenant Stephen A. Modzelewski, USN

Silent Communicator
Midshipman 1/C Kevin C. Harris, USN
Adviser: Lieutenant Peter S. Allison, USN

Rowing Strength Tester
Midshipmen 1/C Eric J. Hawn
and Matthew G. Kelly, USN
Adviser: Lieutenant William B. Taylor, USN

Wall Climbing Robot
Midshipmen 1/C John W. Hawver
and Craig M. Snyder, USN
Adviser: Lieutenant Commander Richard J. McGraw, USN

Eigen 500
Midshipman 1/C Patrick L. Herrera, USN
Adviser: Lieutenant Commander William H. Campbell, USN

ASCII-Braille Converter
Midshipman 1/C Gerald T. Heyne, USN
Adviser: Lieutenant William B. Taylor, USN

Radar False Target Generator
Midshipmen 1/C Karl E. Hill
and Luis E. Yepez, USN
Adviser: Lieutenant Paul E. Thurman, USN

Race Car Timer
Midshipmen 1/C Steven J. Himelspach
Juan A. Silva, USN
Adviser: Lieutenant David S. Gilmore, USN

Jam-Proof Communications
Midshipmen 1/C Allen L. Hobbs
and George M. Kollar, USN
Adviser: Captain Charles B. McClelland, USMC

Sea Goat Navigation
Midshipmen 1/C Cory Howes,
Daniel L. Nyenhuis,
and William A. Peterson, USN
Adviser: Lieutenant William H. Campbell, USN

Radar Defeater
Midshipmen 1/C Douglas C. Huntington
and Timothy A. Johnson, USN
Adviser: Lieutenant Michael K. Johns, USN

Automatic Cable Greaser
Midshipmen 1/C Jon L. Jensen
and William T. Murray, USN
Adviser: Lieutenant David S. Gilmore, USN

Car Stereo Noise Reducer
Midshipman 1/C William A. Kendrick, USN
Adviser: Colonel James F. Kendrick, USAF

Autonomous Helicopter
Midshipmen 1/C Steven M. King
and Jon T. Macharg, USN
Adviser: Commander Michael F. Dulke, USN

Tracking A Ghost
Midshipman 1/C Christopher J. Kipp, USN
Adviser: Lieutenant Commander William H. Campbell, USN

Vibration Analysis
Midshipman 1/C Andrew A. Kiss, USN
Adviser: Colonel James F. Kendrick, USAF

Eigen 500
Midshipman 1/C Ryan J. Kuchler, USN
Adviser: Lieutenant David S. Gilmore, USN

Systems Ball Competition
Midshipmen 1/C Andrew T. Lehmann
and John R. Wallace, USN
Adviser: Commander Michael F. Dulke, USN

Automatic Bass Tuner
Midshipman 1/C Russell E. Marsh, USN
Adviser: Captain Donald S. Smith, USMC

Automobile Heads-Up Display
Midshipman 1/C Robert L. McWilliam, USN
Adviser: Lieutenant Commander Robert A. Shafer, USN

Eigen 500
Midshipmen 1/C Charles D. Morgan
and James Ramirez, USN
Adviser: Lieutenant Stephen C. Lanier, USN

Ring Laser Gyro
Midshipman Adam H. Noble, USN
Adviser: Commander Michael F. Dulke, USN

Systems Ball Cart Competition
Midshipmen 1/C John B. Petroff
and John J. Rusnak, USN
Adviser: Lieutenant Stephen C. Lanier, USN

Systems Ball Cart Competition
Midshipman 1/C Rick M. Radonich, USN
Adviser: Lieutenant Stephen C. Lanier, USN

Sonobouy Signal Processor
Midshipmen 1/C Jason A. Rich
and David M. Smith, USN
Adviser: Lieutenant Commander Michael K. Johns, USN

Eigen 500
Midshipman 1/C Erich P. Roetz, USN
Adviser: Lieutenant Stephen A. Modzelewski, USN

Automatic Volume Control
Midshipman 1/C Samuel S. Scialabba, USN
Adviser: Lieutenant Peter S. Allison, USN

Song Detection
Midshipman 1/C John D. Stevens, USN
Adviser: Lieutenant Peter S. Allison, USN

Remote Car Starter/Climate Control
Midshipman 1/C Luan K. To, USN
Adviser: Captain Scott J. Fuller, USMC

Rotary Inverted Pendulum
Midshipman 1/C Gary A. Walker, USN
Adviser: Lieutenant David S. Gilmore, USN

Publications

BECHERT, Thomas E., Associate Professor, "Modeling of Dynamic Systems," *Proceedings* of the 1992 Pittsburgh Conference on Modeling and Simulation, April 1992, Part 5 pp, 2451-2456.

This paper presents the results of the derivation of the equations of motion for a three degree-of-freedom mechanical system. The system includes a spinning body mounted on elevation and azimuth gimbal bearings, driven by elevation and azimuth servo motors. The result is quite general, in that the centers of mass were not constrained to lie on a axis of rotation, except for the spinning body, where a balanced rotor would be required for satisfactory performance. Further, the axes of rotation were not assumed to intersect. No restrictions were made on the symmetry of structures, except for the spinning body; the model

accommodates products of inertia, in addition to moments of inertia. Lagrangian methods were used to derive the equations. The problem is made tractable by finding the contribution of each component separately, and combining the several effects to complete the mathematical model.

CLEMENT, William I., Assistant Professor, and Terrence E. DWAN, Professor, "A New Automatic Test Equipment and Control/Communications Laboratory at the United States Naval Academy, " Computers in Education Journal of the ASEE, 2, 4 (October-December 1992), 7-11.

The setup and operation of a new Automatic Test Equipment (ATE) and Advanced Control/ Communications Laboratory at the United States Naval Academy is described and discussed. Useful laboratory exercises and procedures with examples are also given.

CLEMENT, William I., Assistant Professor, "Generalization Capabilities of Back-Propagation Neural Networks," Proceedings of the Twenty-Third Annual Pittsburgh Conference on Modeling and Simulation, Part 5, April 1992, pp. 2435-2442.

The generalization capabilities of back-propagation neural networks are explored. This paper examines the ability of a back-propagation neural network to extract generalizations which are independent of object class. Specifically, rotational invariance is studied. The approach taken is to train a neural network on a set of pattern classes which undergo rotation and analyze its response to other pattern classes to see if the generalization extends to these. The results indicate that the generalizations formed by a back-propagation neural network are restricted to those pattern classes on which it was trained.

CLEMENT, William I., Assistant Professor, "Final Report: Application of Neural Networks to Acoustic Data Analysis." Technical report prepared for Naval Surface Warfare Center, Carderock Division, November 1992.

Target strength measurement trials are conducted for the purpose of characterizing and modeling a ship's noise radiation pattern, strength, and source. Such trials are composed of as many as 400 runs during which about 5 minutes of time-domain data from each of 250 hull-mounted accelerometers is collected and recorded. Such volumes of data make real-time analysis impossible. Even the task of

verifying the data's validity (i.e., looking for inoperative sensors) cannot be conducted at the time of the trial. Without some real-time analysis techniques, it is difficult to determine whether certain runs were carried out sufficiently or whether they need to be re-done.

As a first step in the implementation of a real-time analysis system, data validity must be performed. This problem is complicated by the fact that there are a variety of "normal" condition--for example, background noise, shaker noise, and explosive shot noise. In addition, different sensors react differently to excitation so there is further variety in what is termed "normal." Such variety, combined with the volumes of data, suggest that a neural network solution may be best. Neural networks have the ability to accurately categorize data with nonlinear feature-space discriminants. Additionally, multi-modal pattern classes are also correctly classified by neural networks. This means that even if the data for one pattern class is distributed in several areas, these will be accurately grouped by the neural network.

A neural network solution is investigated for applicability to the data validity problem. The aim is to train a multi-layer, feed-forward neural network to categorize data as either valid or invalid. Further, if the data is valid, the network will attempt to discern the current noise condition--background, shaker, or shot noise. Real-time or near real-time operation is the goal.

The back-propagation neural network performed with 100% accuracy on data from the single platform on which it was trained.

DWAN, Terrence E., Professor, "Frequency Shift Keying Simulations in MATLAB," Modeling and Simulation, Instrument Society of America, 25,5 (1992), 2443-2446.

Frequency shift keying uses signals of varying frequencies to convey information. In the case of this simulation a two-thousand Hertz signal represents a high level or a one and a one thousand Hertz signal represents a low level or a zero. Data transmission in this form is highly accurate and, when multiple frequencies are used, difficult to jam. The simulation takes advantage of a high level programming language, Matrix Laboratory or MATLAB. In this language it is easy to use algebra and calculus on the matrices and vectors associated with the simulation.

WATTS, Jerry W., Associate Professor, Terrence

E. DWAN, Professor, and C. George BROCKUS, Associate Professor, "Optimal State Space Control of a Gas Turbine Engine," Transactions of the ASME, *Journal of Engineering for Gas Turbines and Power*, 114 (October 1992), 763-767.

An analog fuel control for a gas turbine engine was compared with several state-space derived fuel controls. A single-spool, simple cycle gas turbine engine was modeled using ACSL (high level simulation language based on FORTRAN). The model included an analog fuel control representative of existing commercial fuel controls. The ACSL model was stripped of nonessential states to profuse an eight-state linear state-space model of the engine. The A, B, and C matrices, derived from rated operating conditions were used to obtain feedback control gains by the following methods: (1) state feedback; (2) LQR theory; (3) Bellman method; and (4) polygonal search. An off-load transient followed by an on-load transient was run for each of these fuel controls. The transient curves obtained were used to compare the state-space fuel controls with the analog fuel control. The state-space fuel controls did better than the analog control.

WATTS, Jerry W., Associate Professor, "Modelling an Intercooler with First Order Lag Time Constants, " Modeling and Simulation, School of Engineering, University of Pittsburgh, 23, 5 (1992), 2329-2336.

A simplified heat exchanger model using first order lag time constants is developed for a gas turbine intercooler. The time constant for the contribution of the cooling water stream to the air side outlet temperature is a function of number of transfer units (NTU1) and heat transfer resistance ratio (air side to water side) (RSTAR1). The three coefficients in the model were obtained using a polyhedral search and matching electromechanical data from Kays and London. Transients run using this model at two different effectiveness values are presented.

WICK, Carl E., Assistant Professor, co-author, "Modeling of Illumination Effects for Image Processing of Microvessels," *Proceedings* of SPIE Medical Imaging Conference, Image Capture, Formatting and Display, 1897 (1993), 35-47.

The paper reports on development of an image processing system that is capable of detecting and tracking blood vessels in photographs or video images of the human microcirculation system.

Presentations

BECHERT, Thomas E., Associate Professor, "Analytical and Graphical Compensator Design Using the Inverse Frequency Response," International Association of Science and Technology for Development (IASTED) International Modelling and Simulation Conference, Pittsburgh, Pennsylvania, 12 May 1993.

CLEMENT, William I., Assistant Professor, "Application of Neural Networks to Shipboard Acoustic Data Analysis," University of Virginia's Mechanical, Aerospace, and Nuclear Engineering Department, Charlottesville, Virginia, 15 April 1993.

MITCHELL, E. Eugene, Professor, and Stephen O. SPRAGUE, Midshipman 1/C, USN, "Fuzzy Logic Control of Rotary Inverted Pendulum," The International Association of Science and Technology

for Development (IASTED) Conference, Pittsburgh, Pennsylvania, 12 May 1993.

MITCHELL, E. Eugene, Professor, and Jay E. Dryer, Midshipman 1/C, USN, "Fuzzy Logic Control of a Balanced Beam," The International Association of Science and Technology for Development (IASTED) Conference, Pittsburgh, Pennsylvania, 12 May 1993.

RASK, Olaf N., Associate Professor, "The Use of the Michelson Interferometer as an Optical Strain Gage," International Association of Science and Technology for Development (IASTED) International Modelling and Simulation Conference, Pittsburgh, Pennsylvania, 12 May 1993.

WATTS, Jerry W., Associate Professor, and Terrence E. DWAN, Professor, "A Reduced Order

State-Space Controller for an Intercooled, Regenerated Gas Turbine Engine," Summer Computer Simulation Conference 1992, Reno, Nevada, 27-30 July 1992.

WATTS, Jerry W., Associate Professor, Terrence E. DWAN, Professor, and Karl F. PRIGGE, Midshipman 1/C, USN, "Design of a State Space Controller for an Advanced Gas Turbine Engine," (IASTED) International Modeling and Simulation Conference, Pittsburgh, Pennsylvania, 12 May 1993.

WICK, Carl E., Assistant Professor, "Modeling of Illumination Effects for Image Processing of Microvessels," International Society for Optical Engineering Medical Imaging 1993 Conference, Newport Beach, California, 14 February 1993.

WICK, Carl E., Assistant Professor, Modeling of Illumination Effects for Image Processing of Microvessels," Annapolis Chapter of Sigma Xi, Annapolis, Maryland, 20 January 1993.

Division of
Humanities and Social Sciences

Economics

Professor Rae Jean B. Goodman
Chair

Research and scholarly activity are essential elements to maintain a vital and viable academic department. The research activity performed by members of the Economics Department during the last year demonstrate the wide range of scholarly activity which engenders an intellectually vibrant environment. One of the primary rationales for faculties at undergraduate institutions to stress scholarly activity is the carry-over to the classroom. A survey of the scholarly activity of the Economics Department clearly demonstrates the relationship between the research and the courses taught in the Economics curriculum. Professor Bowman completed a cost-benefit study of the Naval Postgraduate School curriculum in comparison with curricula at civilian institutions, and developed a methodology to evaluate alternative job training programs. Professor Fredland initiated research in the relationship between the tax system and health care expenses. Assistant Professor Kulchycky's research on international direct investment has expanded into tax system effects and takeovers. Assistant Professor Thierfelder's research interest focuses on international trade and trade agreements. Other significant research efforts include Professor Little's investigations into congressional voting patterns of veterans and into attainment of educational goals by veterans, Associate Professor Gibb's development of social accounting matrices for developing nations, Professor Morris' investigations into the industrial revolution and the development of Economic

Schools of thought in the United States. The military faculty in the Economics Department continues to expand their research interests. Captain Jackson completed a study on race and gender wage discrimination as part of the American Economics Association summer program at Stanford University and Lieutenant Fiorino continued her research into the civilian labor market experiences of female veterans.

The Honors Program midshipmen investigated extremely divergent topics. Midshipman 1/C Richard S. Whiteley analyzed the effects of the North American Free Trade Agreement on stock prices as an application of the Efficient Market Hypothesis. Midshipman 1/C Reza Pouraghabagher investigated two hypotheses: (1) Does the existence and implementation of the death penalty reduce the murder rate; and (2) Is the death penalty imposed in a discriminatory manner?

Professor Coffey, the Manpower, Personnel and Training Research Professor, completed a two-year study of the economic costs for recalled medical personnel during the War with Iraq. The Economics Department greatly appreciates the contributions to the Economics curriculum and research efforts provided by Dr. Coffey. The Economics Department had a very productive year in research with seven presentations at major conferences. Funding support for Economics Department research has come from the Naval Academy Research Council, Bureau of Personnel, and the Naval Postgraduate School.

Sponsored Research

Non-technical Graduate Education Programs in the U.S. Navy: A Cost-effectiveness Study of the Naval Postgraduate School

Researcher: Professor William R. Bowman
Sponsor: Chief of Naval Operations, OP-01/BUPERS 2 DON

The study was completed in December 1992. The purpose of the study was to determine if the Navy could save money by transferring their non-technical graduate curricula out of the Naval Postgraduate School (NPS), Monterey for OP-01. The study concluded that, on average, no savings would be achieved by transferring programs to those in civilian institutions of equal quality.

Instead, a new proposal was derived which could save substantial costs in the Navy education budget. This proposal is based upon making the current tuition assistance program a formal "feeder" program in curriculum deemed appropriate by

Navy. This program would develop the general courses offered in typical civilian graduate schools that could be taken after work hours while officers are on shore duty, or through correspondence courses while at sea. With a validation exam, officers could then be screened to complete their Navy-sponsored Naval graduate degree in Navy-specific courses at NPS. This proposal would save substantial officer pay and housing allowances, which compose two-thirds of the total cost of graduate education to the Navy. This proposal is being seriously considered for adoption by the Navy.

An Empirical Analysis of the Effects of Changes in the Personal Income Tax Treatment of Medical Expenditures

Researcher: Professor J. Eric Fredland
Sponsor: Naval Academy Research Council (OMN)

Citizen access to affordable health care has been a prominent policy issue for many years. To assist in that access, the federal government heavily subsidizes health care. The primary rationale for this subsidization is redistribution--not everyone can afford health care. While subsidies are important, policy makers have also been concerned with containing rapidly rising health care costs. The personal income tax code includes a deduction for medical expenses which appears on the surface, at least, to conflict with the objectives of both cost containment and subsidization. The deduction does not seem compatible with a distributional rationale because its beneficiaries would seem to be high income people. Deductibility is available only to itemizers and the value of the deduction varies directly with income. At the same time the deduction probably exacerbates the cost

containment problem by stimulating increased consumption of health care. Deducted expenses are those which are not insured--and are sometimes uninsurable--cosmetic surgery, nursing home care, etc. The relationship of tax deductibility to the subsidization and cost containment issues has been the subject of a small empirical literature over the last 30 years, but adequate data have not been available to explore the relationship adequately.

A recently available panel data set contains tax return data for 5800 taxpayers for each of eight years, 1979-1986. This time period coincides with significant changes in the tax law, in turn providing ready-made, real time experiments. The objective of this project is to use these data to re-examine the medical deduction to assess its compatibility with redistribution and with cost containment. The specific hypothesis with respect to cost containment

is that taxpayers have discretion regarding some health care expenditures and will thus time them to take advantage of changes in the tax law. The specific hypothesis with respect to redistribution is that for itemizers, medical care tax deductibility is positively related to the long run income.

Results to date are preliminary. With regard to the first hypothesis, some evidence of increasing deductions prior to tightening of the tax law has been found, suggesting that discretionary health care expenditure is stimulated to some degree by tax considerations. With regard to the second hypothesis, no significant relationship between deductibility and income has yet been found, suggesting that the benefits of the deduction do not rise systematically with income.

Toward Resolving the Tension Between Theory and Fact: The Determinants of International Direct Investment and Trade

Researcher: Assistant Professor Ksenia M. Kulchycky
Sponsor: Naval Academy Research Council (OMN)

The objective of this research is to resolve the contradictions between the theoretical and empirical literature of direct investment: Most of the theoretical literature predicts that direct investment is attracted by differences in relative factor endowments between countries. The empirical literature shows that direct investment is attracted to economies similarly endowed to its parent country. The model developed in this paper proposes that these contradictions are a result of inadequate theoretical and empirical analysis of the issues of internalization.

An empirical analysis of the Kulchycky model, which merges internalization and location choice issues of direct investment is conducted. Tobit and Logit analyses were used to determine whether the new modeling of direct investment was supported by the data.

This paper showed, theoretically and empirically, that internalization and location choice are complementary, not contradictory, theoretical models and that both are necessary for a complete understanding of foreign direct investment.

The paper is now being rewritten subject to suggestions given by the Review of Economics and Statistics.

This project was also supported by the National Bureau of Economic Research.

The Differential Effects of Foreign and Domestic Takeovers on U.S. Firms

Researcher: Assistant Professor Ksenia M. Kulchycky
Sponsor: Naval Academy Research Council (OMN)

This paper is an analysis of the effects of foreign takeovers of U.S. firms on the operations of those firms. The recent growth in foreign takeovers of American firms has led to many anxious comments in the press, various proposals for registration provisions, and other legislative proposals for restrictions. Fear of foreign takeovers includes anxiety over excessive foreign influence on our economic and political system, foreign acquisition of proprietary technology and shifting of R&D investment away from the U.S., thereby eroding U.S. competitiveness, reducing employment and skill levels of workers, and transfer of high-tech, high value-added, components of production away from the U.S. Despite the concern regarding foreign takeovers, there has been little research done on their effects.

The theoretical model is being developed and the very time consuming process of data gathering is being done.

This project was also supported by the National Bureau of Economic Research.

Taxes, Income, and Foreign Direct Investment

Researcher: Assistant Professor Ksenia M. Kulchycky
Sponsor: Naval Academy Research Council (OMN)

This research will examine whether taxes affect the distribution of investment and income of U.S. multinationals. Is there strong evidence that U.S. multinationals are able to shift income to their foreign affiliates so as to avoid paying U.S.taxes? This analysis will include theoretical and statistical analysis. This research project is under developement. Data is being gathered, and some preliminary regressions have been run.

This project is also being supported by the National Bureau of Economic Research.

The "Chicago School" and the "Wisconsin School": Fundamental Foundations in the Labelling of Economics

Researcher: Professor Clair E. Morris
Sponsor: Naval Academy Research Council (OMN)

The year 1892 was significantly eventful for the economics profession for it marked the founding of the economics departments at the University of Chicago and the University of Wisconsin. The distinctly different approaches which these two schools took to the study of economics helped to define the young and still evolving discipline and to focus the work of economists for many decades to follow. The tenor of economics at these two Schools so physically close was so distinct and different that economists nationwide wore these institutional labels regardless of where they received their training.

The objective of this study was to explore how the fundamental differences between the "Chicago School" and the "Wisconsin School" came into existence. The intent was to answer the question of whether the differences were due to the nature and character of the founding fathers or to the inherent characteristics of the institutions. A further intent was to find an explanation for why the distinctions were perpetuated within the discipline for so long.

The literature on the early methodological debates within the economics profession was explored to discover the extent to which J. Laurence Laughlin, the first chairman at Chicago, and Richard T. Ely, Wisconsin's first chairman, were important figures. It was confirmed that they were prominent participants in the clashes that took place in the most widely read journals of the time. An attempt was made to assess the important influences on Laughlin and Ely by screening not only their published works, but also their manuscripts and papers that are deposited in the Library of Congress. This part of the work continues.

Dynamic Changes in Mexico's Agricultural Sector

Researcher: Assistant Professor Karen E. Thierfelder
Sponsor: Naval Academy Research Council (OMN)

Mexico heavily protects its corn sector through import restraints. Under the North American Free Trade Agreement (NAFTA), Mexico will eliminate these barriers. This trade policy change will affect Mexico's domestic policy objectives. In this paper the researcher investigates policy options available to mitigate the decline in corn production and rural farm income in Mexico. She then considers investment changes which will indicate the long run impact of NAFTA on Mexican agriculture.

This research is in the preliminary stages. The researcher has developed a Computable General

Equilibrium (CGE) model of the United States and Mexico with a detailed agricultural sector. She will extend the model to evaluate the current policy changes the Mexican Department of Agriculture is considering in conjunction with NAFTA. Using a Mexican household income survey, available at the World Bank, the researcher will extend the description of rural farm income in the model. Investment changes in Mexico will also be considered to simulate the dynamic effects of NAFTA.

Independent Research

Net Impacts of Job Training Programs Using Non-experimental Data

Researcher: Professor William R. Bowman

The purpose of this study was to develop a methodology to evaluate state-wide job training programs funded by the government. This methodology had fallen in disrepute over the last decade due to serious statistical problems that characterized non-experimental evaluation studies. This methodology has been replaced with extremely costly experimental evaluations which have recently come under attack because of their costs and design problems that weaken their policy relevance.

With newly available longitudinal individual earning data and new advanced statistical techniques, it is now possible to replicate the experimental studies with far less costly non-experimental evaluation techniques. This study uses data from the State of Utah to test the feasibility of the new non-experimental technique and finds that the technique yields results that should be reliable for use in supporting employment and training policies.

The study was thoroughly reviewed by two of the leading labor economists in the country (James Heckman of University of Chicago and Howard Bloom of New York University) and should be a significant contribution to the evaluation of government sponsored programs.

Civilian Labor Market Experiences of Female Veterans

Researcher: Lieutenant Susan J. Fiorino, USN

While the literature has documented the socioeconomic characteristics and labor force experiences of male veterans, a void exists in similar research for female veterans. The National Longitudinal Survey of Labor Force Behavior provides a unique opportunity to fill this void and to provide the Navy with information necessary to make informed policy decisions regarding recruiting and retention. Mulitvariate statistical techniques will be used to analyze the data.

Thus far, only the methodological approach and a portion of the literature search are complete.

Defense Contractor Profitability and Tobin's q

Researchers: Professors J. Eric Fredland and Roger D. Little

This project is a continuation of research begun last year under the sponsorship of the Defense Systems Management College. That project had argued that profitability of major defense contractors is apparently driven by the size of procurement budgets and by Defense Department policy regulating profit that can be earned by firms doing defense business. On that basis, the researchers

examined the extent to which these factors--procurement budget size and profit policy--reflected in financial market assessments of these firms. The analytical tool used was the q ratio, first developed by James Tobin and now widely used as a measure of monopoly power and as an approach to measuring the relationship between financial markets and capital investment. It is the ratio of market value of the firm to the replacement cost of its capital stock. In theory, when the q exceeds one, investment in new capital enhances market value. If a firm is in a competitive industry, q will tend to move to unity as entry and/or expansion leads to exploitation of available investment opportunities. In an industry with significant barriers to entry, however, q will tend to exceed one, reflecting the existence of monopoly profits. Defense contractors operate in an environment with significant entry barriers. Their profitability is potentially subject to sharp fluctuation, however, when budgets change and perhaps when Defense Department policy regarding contractor profit changes. If these changes in fact affect profitability to any great degree, they should be reflected in fluctuations in the q ratio. We are using the COMPUSTAT database, which contains financial data on more than 3000 firms over a 30 year period, to carry out this effort. We have continued to expand our database and search for appropriate tools of analysis for handling our time series-cross section data. This effort will proceed over the summer in preparation for a paper which will be presented at the Inter-University Seminar meetings in the fall.

Employment-Based Social Accounting Matrices for Rural Development Analysis

Researcher: Associate Professor Arthur Gibb, Jr.

This research explores the possibility of constructing a SAM for a rural micro-region using employment data as the basis for generating a full set of income and expenditure estimates. For many issues of rural-urban linkage analysis the pressing need is for a more detailed understanding of structure rather than behavior, the latter being fairly well understood by now.

The research is based on the empirical evidence generated by a rural-urban linkages study in a micro-region of Central Luzon in the early 1970's. The basic argument is that the rural economy is relatively simple and permits simplifications identifying skill levels, capital use, and capital origin with particular production activities. It further permits production activities to be identified with the production, consumption, and public service linkages to agriculture. A crucial cross-classification is whether activities are full-time or part-time.

An initial version of the SAM has been estimated. Ensign Benjamin Reynolds helped with putting it into a spreadsheet file. The SAM will subsequently be subjected to various consistency tests, especially comparing its results to those of other regional SAMs.

Race and Gender Wage Discrimination

Researcher: Captain Eric K. Jackson, USMC

The Current Population Surveys (CPS's) for May 1985 and May 1978 were analyzed to determine whether and how the returns to (1) education and (2) experience varied by race and gender. Experience-earnings profiles for males versus females and whites versus non-whites were estimated and interpreted. OLS regressions were run to determine wage differentials with respect to experience and education. Some of the results are summarized in the following.

In the case of returns to education, analysis of the data from 1978 and 1985 indicated that there was no significant difference between returns to education received by whites and non-whites over all education levels. Simply, if two individuals, one white and the other non-white, were to have the

same amount of education, their net "return on schooling" would be the same. There are indications that the earnings gap, which favors whites, is lessened at higher education levels. Again the two data sets; analysis indicates that there was a significant difference between returns to education for males and females. In fact, the returns education for females was higher than it is for males. Thus, it would suggest that females should be more likely to go to school and for a greater period of time than males, because of greater returns.

During the seven-year period, non-whites and white females experienced an increasing return to work experience, relative to white males. The returns to experience over time tended to favor male, according to the data for 1978 and 1985. The situation improved for females in 1985. However over time, male still tended to gain from experience at a greater rate than females. Thus, one would expect males to be more likely to enter the labor force earlier than females, because their returns to experience are higher and their returns to education are lower than for females.

Voting on Defense and Veterans Issues by Military Veterans in the Congress

Researcher: Professor Roger D. Little

The purpose of this research is to determine whether or not military veterans who are serving in Congress vote differently on defense and veterans issues than those who have no military experience. The study is motivated in part by the likelihood that the numbers of veterans in the Congress will diminish in the foreseeable future and this occurrence may reduce support for defense in general. The database for the Senate, covering five congresses, is complete and the House database is partially completed; both will contain the personal characteristics of congressmen, economic data on their states and districts, and ideological data on past voting behavior together with their recorded votes on important defense and veterans issues. The statistical approach to determine the significance of the characteristic, "veteran," is based on bivariate probit analysis. No results have been reached at this time.

Attaining Educational Goals: How Do G.I.s Compare

Researchers: Professor Roger D. Little and Ensign Sam Meckey, USN

At the inception of the All-Volunteer Force, and for a number of years thereafter, the quality of the force was a major concern of the military and the military manpower community in particular. Force quality was examined by Professor Little and Fredland in a 1984 paper. The present effort updates that paper through 1990 and extends the analysis to women. This paper concludes that, although the military members were of a quality equal to their civilian counterparts and initially had espoused much higher educational goals, G.I.s subsequently kept up with their civilian cohort in terms of educational gains; their higher educational goals have gone largely unfulfilled some nine years later. The quality and experiences of women who joined the military largely parallel those of military men.

The purpose of the research was to determine if the higher educational goals of military personnel subsequently had been attained. The investigation used National Longitudinal Survey data which contains over 10,000 individuals. Statistical differences in sample means was the primary methodology. The paper is ready for submission.

Sabbatical Research---Adventure in Economic History: Regional Foundations of the Industrial Revolution

Researcher: Professor Clair E. Morris

A sabbatical was granted for fall semester 1992 for the purpose of exploring the region of England where the first industrial revolution began. This region is more or less bounded in a triangular shape by Liverpool/Manchester in the west, Leeds in the east, and Sheffield in the south. Many of the original machines that were responsible ultimately for mechanical mass production of textiles have been preserved within industrial museums. Some of the early 18th century factories in the area have also been restored. The objective of this project was to physically visit sites and museums, and to "lay eyes" on the machines that were so significant in ushering in a world shattering process that continues even to this day. It was anticipated that a greater understanding of the Industrial Revolution could be attained that would pay pedagogical dividends in the future.

Manchester/Bolton was the site where many of the most important inventions were displayed. Among the restored machines were the flying shuttle patented by John Kay in 1733, drafting rollers put in place by Lewis Paul in 1738, the spinning jenny invented by James Hargreaves in 1770, Richard Arkwright's water frame, roving frame, and draw frame invented 1769-1775, Samuel Crompton's spinning mule patented in 1779, and the power loom invented by Edmund Cartwright in 1785.

Bradford, slightly east of Manchester, was where a 19th century planned/model industrial village, Saltaire, was visited. The village with its 22 streets, 850 houses, stores, a church and 45 alms houses is located on the Liverpool/Leeds Canal, and still has a mill that is producing textiles. Many of the restored early steam engines that had been used to power the newly invented textile machines were viewed in Bradford's Industrial Museum just down the street from Saltaire. Farther east lies the manufacturing city of Leeds, home of Armley Mills, which has been converted into the city's industrial museum. Here was seen the early carding and spinning machines that made Leeds, at one time, the worsted woolen capital of the world. Leeds was also where one of the largest water wheels that had ever been used to move industrial machinery was seen.

Sheffield, a steel and cutlery center for the past two hundred years, lies south of Leeds and is the home of one of the best industrial museums in the area. Among other artifacts, a 12,000 horsepower steam engine that was used to roll steel slabs was observed still in workable condition.

The last part of the sabbatical was spent in Dartmouth, England, where the Britannia Royal Naval College (BRNC) is located. Six lectures on history of economic thought were delivered at BRNC.

Trade and Employment in General Equilibrium

Researchers: Assistant Professor Karen E. Thierfelder

In neoclassical trade analysis, factor markets are perfectly competitive, an assumption which implies a uniform wage across all sectors. Empirically, however, wages do vary by sector. Studies show that the wage differentials persist even after accounting for the obvious explanations such as differences in human capital or job hazard. In this paper, the researcher considers the implications for wage differentials on trade policy. Two explanations for wage differentials are considered: the existence of unions in a sector, or a sector that pays efficiency

wages. The researcher evaluates the policy implications for each explanation of the observed wage differential. The paper includes an analytical section in which we demonstrate the impact wage differentials have on output and factor price changes following a change in the output price. The researcher then considers a stylized empirical model in which we determine the optimal policy response to the wage differential.

The paper is being presented at the Western Economic Association Meetings; it will be included

in a book, *Applied Trade Policy Modeling: A Handbook*, to be published by Cambridge University Press.

Data Requirements for A Computable General Equilibrium Model of the United States and Mexico: Technique to RAS an Unbalanced Matrix

Researcher: Assistant Professor Karen E. Thierfelder

Since the data required for a Computable General Equilibrium (CGE) model comes from different sources there are slight inconsistencies in the numbers. In a comparative static model, however, the base year must balance perfectly. A RAS technique allows one to adjust rows and columns of a matrix such that the row sum equals the column sums, a requirement for the base data. In this paper a RAS technique in the General Algebraic Modeling Software (GAMS) is developed. A general procedure to RAS any matrix is described; also the specific data adjustments specific to Mexico's input-output and macro-economic data are documented.

This paper will be published as a technical bulletin through the U.S. Department of Agriculture's Economic Research Service.

U.S. Domestic Agricultural Policies and the U.S.-Mexico Free Trade Agreement

Researcher: Assistant Professor Karen E. Thierfelder

Using a computable general equilibrium (CGE) model of trade between the United States, Mexico, and the rest of the world, the researcher simulates policy changes under G.A.T.T., which reduces domestic agricultural support in most countries, and under the North American Free Trade Agreement (NAFTA) which eliminates trade barriers. If the G.A.T.T. round is completed first, it will include changes in U.S. domestic agricultural programs. How will these changes affect trade between the United States and Mexico, of which a large component is agriculture? How will the policy changes from the G.A.T.T. negotiations affect the policy changes under NAFTA?   Likewise, if NAFTA is completed before the G.A.T.T. negotiations, what will the subsequent policy changes recommended in the G.A.T.T. negotiations be? The preliminary results suggest that G.A.T.T. policy changes will have a bigger impact on the United States than on Mexico while NAFTA will have a bigger impact on Mexico than on the United States.

This paper will be presented by my co-author, Sherman Robinson, at the American Agricultural Economics Association Meetings in August 1993.

Consumer Surplus with Reservations

Researcher: Associate Professor A. Royall Whitaker

Consumer surplus is defined as the excess of what a consumer would have been willing to pay over what he or she did pay. It is said to be an objective of price discrimination to capture that surplus. Price discrimination is the varying of price according to variations in demand, not variations in cost-- sometimes illegal, but often not. Three degrees are commonly recognized but it is the investigator's contention that, correctly understood, the concept of consumer surplus does not support the first two. The analysis is, first of the logical impossibility of the first two degrees, second, of the actual third degree nature of alleged examples, and third, of the consequences of accepting the argument, which are

generally to simplify the theory of price discrimination and of oligopoly pricing generally.

Research Course Projects

The Deterrence Effect of Capital Punishment

Researcher: Midshipman 1/C Reza Pouraghabagher, USN
Adviser: Associate Professor Thomas A. Zak

Capital punishment is a controversial issue with complex moral, legal, and policy dimensions. This research examines two of the more important policy questions: (1) Does the existence and implementation of the death penalty reduce the murder rate, ceteris paribus; and (2) Is the death penalty imposed in a discriminatory fashion? Using pooled cross section-time series data, and controlling for other sociodemographic, economic, and policy variables that could affect the murder rate, regression equations are estimated. Correcting for autocorrelation and multicollinearity, no statistically significant deterrent effect of capital punishment is found. In addition, for this time period, there was not a statistically significant difference in black/white execution rates.

A Stock Market Test of the Effect of NAFTA on American Firms with Substantial Direct Investment in Mexico

Researcher: Midshipman 1/C Richard S. Whiteley, USN
Adviser: Associate Professor Thomas A. Zak

There has been substantial debate about the likely effects of the North American Free Trade Agreement (NAFTA). Economic analysis suggests that reducing trade barriers will result in increased exports from the United States to Mexico with benefits for both countries. The increased profitability of firms trading with Mexico should be reflected in their stock prices. The empirical results lend support for the weak form of the Efficient Market Hypothesis--all information about future profitability is captured in stock prices. There is also evidence that NAFTA will have a greater effect on the stock prices of firms in industries where tariff elimination occurs relatively quickly.

Publications

LITTLE, Roger D., Professor, co-author, "Tied Migration and Returns to Human Capital: the Case of Military Wives," *Social Science Quarterly*, 73, 2 (June 1992), pp. 324-339.

The frequent rotation of military personnel provides a unique opportunity to study the consequences of tied migration on a group of women whose moves are anticipated and largely independent of economic forces. Possible consequences include reduced labor force participation and hours of work and lower returns to various forms of human capital investment. The analysis confirms these consequences and suggests that a three- versus six-year rotation policy reduces military wives' earnings by 40 percent.

MORRIS, Clair E., Professor, "Review of The Scottish Contribution to Modern Economic Thought," ed. by Douglas Mair, (Aberdeen: Aberdeen University Press, 1990), *Southern Economic Journal*, 59,1 (July, 1992), 133-134.

This is a long review of a book that chronicles the extensive and significant contributions of 17th, 18th, and 19th century Scottish economists to the classical tradition. As might be expected, Adam Smith gets most the attention, but others like Sir James Steuart, David Hume, and John Rae receive their due. The authors of the articles are all well known names in the field of history of economic thought, e.g., Hutchison, Recktenwald, O'Brien, Skinner, Meek, Peacock, Dow, and Macfie. In the review, each article is analyzed and assessed for the insight and understanding of its subject and for its originality. There is no doubt that this book will become a major item on the reading lists of graduate courses in the history of thought, and will be on the shelves of all serious scholars in the field.

THIERFELDER, Karen E., Assistant Professor, co-author, "Agriculture and Food Polices in a U.S.-Mexico Free Trade Area," *North American Review of Economics and Finance*, Fall 1992, pp. 117-139.

This paper analyzes the effects of a U.S.-Mexico free trade agreement (FTA) on agriculture. The researcher uses a 28-sector, three-country computable general equilibrium (CGE) model in which she explicitly models agricultural and food policies in both countries, and differentiate land types. Agricultural policies include tariffs, quotas, input subsidies to farm and food processing sectors, targeted producer prices, fixed retail food prices, and deficiency payments. Subsidies to Mexico's food processing industries and deficiency payments are endogenous, rather than fixed, ad valorem, price wedges. The model is used to explore the effects of full and partial liberalization of agriculture in an FTA, a restructuring of Mexican domestic farm policies in conjunction with an FTA, and the effects of an increase in the Mexican capital stock. The researcher finds that there is potential for Mexican farm program changes to assist agriculture's transition to a free trade environment, and that in the long term, increased capital investment will enable Mexican agriculture to benefit from free trade.

THIERFELDER, Karen E., Assistant Professor, co-author, "Data Requirements for a Computable General Equilibrium Model of the United States and Mexico," USDA/ERS Staff Report No. AGES 9225, October 1992.

This paper documents the database for a 28-sector, agriculture focused computable general equilibrium (CGE) model of U.S. and Mexican farm programs and trade policies. The database for each country in the U.S.-Mexico CGE model includes: a social accounting matrix (SAM), data on domestic farm programs, data on trade policies (tariffs, export subsidies, and tariff equivalents of quotas), and elasticities assumed for production and consumption functions. This report presents the database and describes sources of the data.

Presentations

BOWMAN, William R., Professor, "The Retention and Promotion of ROTC Officers: Does College Matter?," Fifth Region NROTC Annual Meeting, Northwestern University, Chicago, Illinois, 10 October 1992.

BOWMAN, William R., Professor, "Navy Supported Graduate Education Alternatives," Naval Postgraduate School, Administrative Sciences Department, Monterey, California, 30 November 1992.

KULCHYCKY, Ksenia M., Assistant Professor, "Transactions Costs and Geographical Distribution of Investment," Western Economic Association International Meetings; San Francisco, California, 10 July 1992.

KULCHYCKY, Ksenia M., Assistant Professor, "Taxes, Income, and Foreign Direct Investment," Western Economic Association International Meetings; Lake Tahoe, California, 23 June 1993.

MORRIS, Clair E., Professor, "Reflections on Britain's Economic Performance," Probus Club (retired businessmen) of Dartmouth, England, 2 December 1992.

MORRIS, Clair E., Professor, "History of Economic Thought," Royal Naval Engineering College at Manadon, Plymouth, England, 23 and 28 October, 6 November, and 4 December 1992.

THIERFELDER, Karen E., Assistant Professor, "Trade and Employment in General Equilibrium," Western Economic Association International Meetings; Lake Tahoe, California, 23 June 1993.

English

Professor Charles J. Nolan, Jr.
Chair

Again this year English Department faculty members were extraordinarily productive, publishing several books and a number of journal articles and giving a variety of conference papers. Assisted by institutional support, department scholars worked in diverse areas. Specific topics supported by the Naval Academy Research Council included historical-cultural studies in eighteenth-century art, studies of cross-cultural literary treatments, and literary criticism treating various genres. Instructional Development efforts were focused on computer-assisted pedagogy, developing a program to enhance the ability of midshipmen to skillfully edit their own writing. In addition, independent research covered a wide spectrum of topics, ranging from instruction in creative writing (a textbook) to its varied practice (poems, short stories, and a novel). Other scholars investigated local history, fictional themes, and contemporary literature. Midshipman research directed by faculty members complemented these efforts; three English majors completed significant projects in literary studies.

Earlier research also came to fruition this year. Six books were published; one more is forthcoming; and over two dozen scholarly articles, creative works, and reference essays were printed. Faculty members also presented conference papers at an average rate of twice a month during the school year. The English Department was also honored to have one of its members, Major Jonathan R. Eller, USAF, selected as the first officer faculty member in Naval Academy history to be promoted to the rank of Professor. The kind of paradigm this work reflects--self-generated efforts that are supported by institutional funding and that culminate in published work or conference papers--keeps the department vital and effective in its support of the Naval Academy mission. In the end, all of our research and publication focuses ultimately on one objective-- the very best education for midshipmen.

Sponsored Research

Postcards from the Trenches: Negotiating the Space between Modernism and the First World War

Researcher: Assistant Professor Allyson Booth
Sponsor: Naval Academy Research Council (OMN)

The researcher has completed a book manuscript about the relationship between modernism and World War I. It is under consideration at Oxford University Press. Though many of the works we now identify as distinctively modernist were produced during the war years, few of them are the projects of soldiers. Thus, the gap between soldier and civilian--one of the most complicated features of the relationship between literary modernism and cultural history --structures the attempt to understand both how modernists responded to World War I and ways in which they protected themselves from its grisly details. Throughout the work, the researcher traces ways in which literary and architectural modernism participated in a culture shaped and traumatized by war.

The Object of Beauty: Sublime Suppressions of 18th Century Art

Researcher: Associate Professor Laura Claridge
Sponsor: Naval Academy Research Council (OMN)

"The Object of Beauty" examines the British Enlightenment and Romantic treatment of the object in and of art. Instead of concentrating on the sublime, which has been the emphasis of most scholars studying the aesthetics of this period, the researcher will explore the ideology of beauty that held sway in eighteenth-century England. Thus this study shifts the critical attention away from the spectator's role so usefully explored over the past twenty years of scholarship to a social situating of the artifact itself, though implicating the psychology of a cultural anxiety over the role of the beautiful object as well. The over-valuation of the sublime as the place of unbounded aesthetic experiences begins to appear a defensive move against the encroachments of the beautiful art object upon the spectator's self-possession; paradoxically, in the sublime experience that would seem to consist exactly of losing oneself, one instead is reassured of autonomy and control by virtue of being able to recall the self following the emotional turmoil. The effect of beauty, and by extension, of art predicated on the claims of beauty, seems, however mysteriously, to be controlled by a dynamic outside the subject's command.

Feminine Shadows: Lear's Fool in the Nineteenth Century

Researcher: Assistant Professor Anne-Marie Drew
Sponsor: Naval Academy Research Council (OMN)

In 1838 the Victorian actor-manager Charles Macready restored the role of the Fool to Shakespeare's tragedy, *King Lear*. Macready's production was the first to include the court jester since 1861 when Nahum Tate excised the role from the play. Moreover, Macready cast the Fool as a woman. Macready's decision started a trend that lasted throughout the 1800's. No one has yet documented the frequency of the performances in which the Fool was played by a woman. More importantly, no one has yet discussed the significance of those performances. This study begins the documentation and the discussion.

The West in China and Hong Kong

Researcher: Associate Professor Bruce E.Fleming
Sponsor: Naval Academy Research Council (OMN)

One of the most vital areas of contemporary literary criticism considers the ways in which written texts and other art objects express the point of view of a specific cultural group. Within this area is a sort of criticism that considers what are usually called "cross-cultural" issues, concerned with the portrayal of one culture by another in literature, and with the way in which the artifacts of one are treated by another. Such studies, frequently informed by current anthropological research, allow generalizations about the way one culture comes to terms with another, and may chart relations between the West and other culture over time.

This research project primarily considers fiction and secondary analysis by westerners about China and Hong Kong, as well as by Westernized Chinese and by the British citizens of the Crown Colony of Hong Kong, itself an example of "cross-cultural" pollination. Insofar as possible, the project also considers the plastic arts and how they have developed under the influence of such cross-pollination.

Making Dew Haste in Andrew Marvell's To His Coy Mistress

Researcher: Associate Professor C. Herbert Gilliland
Sponsor: U. S. Naval Academy Sabbatical

The paper offers a new reading of this major 17th century poem. The reading is based upon evidence drawn from botany, historical accounts, evidence from. contemporary work by Marvell and other poets, biblical parallels, and close analysis of the work itself(e.g., pronoun patterns). The result is a poem that is more spectacular in its imagery and more expressive of transcendent mutuality, while less assertively masculine than has heretofore been often thought. Additionally, the reading incorporates solutions to the poem's famous cruxes.

An Interactive Program to Teach Editing

Researcher: Professor Allan B. Lefcowitz
Sponsor: Naval Academy Instructional
Development Advisory Committee

Using Matrix Layout, a hypertext/object-oriented program writer that enables the user to create stand-alone programs, the researcher continues to develop and refine computer software intended to increase student abilities to edit their own writing by leading them to identify and propose solutions to high-frequency problems in rhetoric, grammar, and mechanics as those problems appear in the context of sentences and paragraphs. Instructors will be able to target individual students for work on specific weaknesses rather than devoting class time to discussion of some error only a few students commit. Finally, examples can be expanded and updated constantly without revision of the basic programming. The major thrust of the project is to exploit the three-dimensional potentials of the computer to create opportunities for active rather than passive instruction.

The History of James Longman, Eighteenth-Century Music Seller

Researcher: Assistant Professor Nancy Mace
Sponsor: Naval Academy Research Council (OMN)

Research in London has uncovered a large number of lawsuits involving the music seller James Longman and his partners. These suits are particularly interesting because, while we know a great deal about book copyright in the eighteenth century, scholars do not fully understand the struggles that ensued in the late eighteenth century over music copyright, considered distinct from book publishing. This project is in the preliminary stages, but it should yield valuable information about the connections among various music sellers and about the events that clarified the nature of music copyright and its relation to the theatre and book publishing.

Of This Village: Civil War Letters to The Narragansett Weekly: Early War 1861-1862.

Researcher: Associate Professor Robert D. Madison
Sponsor: Naval Academy Research Council (OMN)

The culmination of a multi-year project, this year's research resulted in a documentary portrait of the village of Westerly, Rhode Island, in the opening years of the Civil War. Two new editions of regimental histories, with introductions based on this material, have been accepted for publication by a press specializing in Civil War reprints. One of these, about the First Rhode Island Cavalry, was originally written by a resident of the town, Frederic Denison, and utilizes in its new introduction material assembled during the primary research.

Rocking the Cradle of the Navy: The Naval Academy Career of William Oliver Stevens

Researcher: Professor Michael P. Parker
Sponsor: Naval Academy Research Council (OMN)

Anyone with even the slightest interest in naval history knows of Alfred Thayer Mahan and the tremendous influence he exerted upon modernization of the U.S. Navy at the turn of the century. Largely forgotten, however, are the men who transmitted the ideas of Mahan to naval officers and who revolutionized the teaching of naval history--the civilian professors of the Naval Academy's old English department. Preeminent among this new generation of naval historians was William Oliver Stevens (1878-1955). The author of 47 books during the course of a long life, he emerged during the second decade of the twentieth century as the most authoritative and most imaginative of the many civilian writers on naval affairs. His *History of Sea Power* (1920), co-authored by Allan Westcott, was the first textbook to survey the influence of seapower from the ancient world to modern times; it remained a required text at the Academy for thirty-five years. Steven's brilliant career at the Academy came to an abrupt end in 1924 when the superintendent, Rear Admiral Henry B. Wilson, refused to renew his contract. Officially, Stevens was let go for reasons of economy; the full story, in fact, is a complex fabric that weaves together naval politics, academic freedom, family feuds, and the recurrent controversy over the place of the civilian faculty at the Academy.

A Critical Study of Mary Gordon's Fiction

Researcher: Associate Professor Eileen Tess Tyler
Sponsor: Naval Academy Research Council (OMN)

This project is a book-length study of the thought and work of Mary Gordon, a highly acclaimed contemporary American writer. The book traces Gordon's development as a novelist and short story writer from several perspectives: (1) her aesthetic, religious, social, and political ideas articulated in her many essays, reviews, and interviews; (2) the Irish immigrant tradition in America; (3) the Christian tradition, especially as it relates to Roman Catholicism; (4) the tradition of fiction by and about women, especially those works to which Gordon has consciously acknowledged her indebtedness; and (5) the perspective of ideas about houses, domestic spaces, and shelter, a crucial symbolic complex pervasive throughout Gordon's writing. This study consists of an introductory chapter, a chapter on Gordon's short stories, chapters on each of the four novels in turn, and a conclusion.

Independent Research

"Surprised by Joy": Play and Sport in Kosinski's <u>Passion Play</u>.

Researcher: Professor Neil Berman

Work continues on this Kosinski project. Time has been used to research pertinent materials in the philosophy, anthropology, and psychology of play and sport necessary to the interdisciplinary approach of this project.

And the Time for it was Gone; The Failure of Time in Marsha Norman's <u>Night Mother</u>.

Researcher: Assistant Professor Anne-Marie Drew

In Marsha Norman's play, *Night Mother*, Jessie Cates announces one evening that she is going to kill herself with her father's gun. Her mother spends the evening trying to change her daughter's mind. Jessie's suicide, when it finally does come, is not so much an act of despair as a triumph. In this paper, Jessie's death is discussed within the historical framework of suicide. Suicide is not seen as an ultimate good here, but Jessie's death is not as meaningless and senseless as might at first appear.

The Body Eclectic: Sources of Ray Bradbury's Martian Chronicles

Researcher: Major Jonathan R. Eller, USAF

Between 1941 and 1949, Ray Bradbury wrote at least forty science fiction stories about Mars, focusing on traditional American themes of exploration and the pioneer spirit extended to new frontiers of space. In 1949, Doubleday contracted for a novel based on these stories, and Bradbury heavily revised a select group of them, added new ones, and wrote eleven bridging chapters for the new book. The *Chronicles* continued to evolve after publication, resulting in five variant forms which remain in print today.

The complex textual history of *The Martian Chronicles* remains the great untapped source of information about Bradbury's process in writing his first novel. Viewed as process, the transformation of these tales helps to define the structural unities of the book, and to determine just what kinds of book it is.

This study traces the evolution of thematic unity as these stories were reshaped into a single work. In its final form, the *Chronicles* becomes an imaginative exploration of the romance and reality found in any frontier experience, and reminds us that the invasion of a new frontier has a cost for both the displaced and the displacers. The study also makes a strong case for the argument that the textual history of a work can have a crucial impact on its genre classification. From a bibliographical point of view, *The Martian Chronicle*, like *Go Down, Moses*, is more a novel than such "bricolage" cousins as *Winesburg, Ohio* and *The Red Pony*, where pre-existing parts become a whole without substantial internal transformation. Discourse of the latter kind works within the frameworks limitations of the existing materials; that is, the author "assembles" rather than "creates" the larger work, building from extant stories which share unifying elements. From the bibliographer's perspective, one may easily see how more ambitious experiments like *The Martian Chronicles* transcend the limitations of pre-existing materials through the revising hand of the author.

The study includes annotated checklists of the individual *Chronicles* chapters, the variant *Chronicles* editions, and Bradbury's unchronicled Martian stories.

A Descriptive Bibliography of Robert Penn Warren, 1921-1991

Researcher: Major Jonathan R. Eller, USAF

This new project is based on James A. Grimshaw, Jr.'s standard Warren bibliography. It updates the record of Warren's work from 1921 until his death in 1989, and includes posthumous editions published through 1991. Books by Warren, as well as those edited or compiled by him, are fully described in this volume, which includes first edition title page facsimile, state and printing variations, subsequent editions, and holdings for each book.

Warren's shorter work in periodicals, newspapers, anthologies, and other publications is listed and annotated in subsequent sections. Significant secondary work also appears in the book, which is illustrated and fully indexed.

This research was performed in collaboration with Professor James A. Grimshaw of East Texas State University.

The Ray Bradbury Pocket Companion

Researcher: Major Jonathan R. Eller, USAF

A true companion to Bradbury's fiction, covering his most significant work in all its forms--stories, story collections, novels, radio/screen teleplays, and drama. Bradbury's fiction titles appear individually, arranged by date of first publication. Each entry is comprehensive--it includes cross-references to later publication in periodicals, in Bradbury's own story or drama collections, novels, or other genre forms. Story entries include a listing of all anthology appearances as well.

Each entry then becomes the header for a plot summary. For the many cases where Bradbury subsequently revised a story or turned it into a play or other form of fiction, the entry will discuss all variant forms and characters. A character census or catalog will follow in another chapter, again identifying the way that many characters are transformed in subsequent versions of some stories. End matter includes a table of known Bradbury

manuscripts, a description of the major Bradbury collections at Bowling Green and UCLA, selected bibliography, and an index of titles.

The fiction companion allows readers to trace the evolution of one of the most textually complex and prolific talents in contemporary literature, a master of fantasy, science fiction, mystery, detective, and horror genres who has won the praise of mainstream literary critics. Taken together, the plot and character chapters may log as many as 7,500 cross-referenced entries. This is perhaps the only way to catalog and fully evaluate Bradbury's impact as a storyteller over more than five decades. The title of *The Ray Bradbury Pocket Companion* acknowledges and builds on Bill Nolan's pioneering *Ray Bradbury Companion*, and also defines the "pocket" project as a focused study of the best--but not all-of Bradbury's writing.

Vision and Revision: The Evolution and Nature of Robert Hayden's Habits in Poetic Composition

Researcher: Professor Fred M. Fetrow

This project involves comparative analysis among various versions of Robert Hayden's poetic works over the expanse of his career and development as a poet of power and wisdom. The progression or evolution from early efforts to polished definitive versions of the same poem can reveal as much about Hayden's techniques, work habits, and moral vision as do the final products themselves. In effect, through this approach to the poetry, one can discern not just "work in progress," but a poet in the making. The collective result is a portrayal of artistic technique and moral priorities--a profile of the artist through close analysis of the artistic process.

The Korean War in American Literature

Researcher: Professor Philip K. Jason

Little critical commentary has been written about literary responses to the Korean Conflict. These writings have suffered from the same collective amnesia that has affected the war itself. The purpose of the project is to explore the fiction, poetry, and plays that imaginatively recreate this episode in American military, political, and cultural history. The goals of the project are to discover: (a)the magnitude of the literary response, (b) the critical attention or lack thereof, (c) the major attitudes, themes, and techniques revealed in the works, (d) the literary and cultural importance of representative works, and (e) parallels and contrasts between Korean War and Vietnam War literature. One special concern will be to compare and contrast the literature written during or immediately after the Korean War with that written at the distance of a decade or more.

Science Cannot Be A Higher Calling

Researcher: Professor Allan B. Lefcowitz

This project involves research on an article (a portion of which was delivered as an address at the Literature and Technology Conference in the fall).

Clearly, despite all its explanatory and practical power, for most of the Victorian sages science simply will not do as the foundation for an education much less as a vocation, a higher calling. The complex reasons for this rejection of science appear to lie in (1) their attitudes toward science as a passionless activity, (2) their understanding about the methods and sources of science, and (3) their emotional and economic investment in the old dispensation.

By the Nineteenth Century, technological, scientific, geographic, political, and economic expansion had multiplied occupations and had devalued or, at least, forced the revaluation of such traditional occupations for the educated and/or privileged as minister and aristocrat/warrior. In the past, by birth or selection, they had literally been called to the work they did, work which was also a position, a rank in society. Therefore, the collapse of the old religious and social dispensations mostly touched the intellectual and entitled classes whose traditional vocations came to seem either insignificant and outworn or as needing serious new justification. The crisis in faith--what should I believe?--often manifests itself dramatically as anxiety about vocation. What work shall I do? For what work am I fit? And, sometimes more to the point, what work is fit for me socially? Even when masked as a question about belief and duty, this triad of questions about the answerable vocation

informs a good deal of the Victorian sages' angst expressed in their prose and poetry.

The article explores how this angst specifically manifests itself in the work of such writers as Carlyle, Arnold, and others.

Henry Fielding's Novels and the Classical Tradition

Researcher: Assistant Professor Nancy Mace

Although scholars have noted that Henry Fielding often uses classical allusions and quotations in his novels, they have underestimated the importance of the classics to our understanding of his audience, sources, characterization, and rhetorical techniques. By studying his classical references within the context of what readers in the eighteenth century knew about ancient literature, we gain new insights into Fielding, his readers, and genealogy of his fiction.

History of the Grammar Patent, 1547-1620

Researcher: Assistant Professor Nancy Mace

Because it involves some of the most important members of the Stationers' Company and is one of the few royal patents granted continuously from the sixteenth through the nineteenth centuries, the grammar patent can add substantially to our knowledge of the developments leading up to the first copyright law in 1610 and to our understanding of the dynamics of the seventeenth- and eighteenth- century booktrade. This project traces the history of the patent from 1547 to 1620; this period in history is not clearly understood by scholars. The research has revealed that the patent was considered one of the most valuable granted to printers; it has also uncovered the identities of several individuals who were not known to be involved with the grammar.

The Artistry of John Irving's Novels

Researcher: Professor Charles J. Nolan, Jr.

The researcher continues a careful and thorough reading of John Irving's novels and the criticism written about them to see if several ideas he has about the way Irving structures his works might enrich our understanding of this talented contemporary figure. Specifically, in two recent novels Irving seems to arrange his texts so that there are dramatic and bipolar shifts in tone. In his earlier works, Irving relied upon a three-part structure to shape his subject matter, and one of the best analyses of his recent *The Hotel New Hampshire* argues that Irving continues his tripartite method in it. But such a view fails to account for the tonal antithesis that is an important aspect of the novel's impact on its readers. *The Cider House Rules* also embodies tonal dichotomies, as Irving resolves the issues he addresses in that book. Just how Irving's latest book, *A Prayer for Owen Meany*, fits into this schema is an important issue to be addressed. The question of structure and tone(and other standard literary devices), then, are the energizing principles of the project and will be the focus of further research.

The English Breton Lays, Sir Orfeo and Sir Launfal

Researcher: Associate Professor Timothy D. O'Brien

Done for the *Dictionary of Literary Biography*, this study examines the group of poems in Middle English referred to as Breton Lays. The project seeks to define the genre and to locate its literary heritage, and especially the influence upon it of Marie de France.

Chaucerian Satire

Researcher: Associate Professor Timothy D. O'Brien

The aim of this project is to develop a theoretical and historical groundwork for reading Chaucer's *Canterbury Tales* as a satire. Though much commentary on Chaucer praises the satiric elements in his works, only two books take a rigorous, generic approach to his satire, and they cover very little of the *Canterbury Tales*. This project will focus on works describing Chaucer's society, on studies in the genre of satire and in genre theory, and on other satiric works of Chaucer's age.

An Edition of the Poems of Edmund Waller

Researcher: Professor Michael P. Parker

Although one of the most accomplished and influential poets of the seventeenth-century, Edmund Waller has remained largely neglected by modern critics. This neglect is due primarily to the lack of a reliable standard edition of his works. The most recent edition, that of George Thorne Drury, was published one hundred years ago, in 1892, and it fails to meet the exacting standards of editorial practice established by W. W. Greg, Fredson Bowers, and Thomas Tanner in the twentieth century. Several scholars have begun new editions of Waller over the past seventy-five years, but none has been brought to completion. Most recently, Philip R. Wikelund of Indiana University labored over an edition from 1954 until his death in 1989.

In 1991 Professor Wikelund's literary executor, Professor Earl Miner of Princeton University, asked me to take over Wikelund's work, and I have agreed to do so as co-editor with Professor Timothy Raylor of the University of Sheffield. Our first goal is to produce a census of Waller editions and manuscripts as well as a complete bibliography of secondary works on Waller. The second goal is to reexamine Wikelund's theory of the Waller copy-text: his choice of the 1664 edition may not conform to modern editorial practice. This project is large in scale and will take a number of years to complete, but the result will be a major contribution to modern scholarship.

A History of Presidents' Hill in Annapolis

Researcher: Professor Michael P. Parker

The area of Annapolis now known as Presidents' Hill lies between West Street, Taylor Avenue, and the old Baltimore, Washington, and Annapolis Railroad right-of-way. It consists of four streets: Munroe Court, Madison Place, Hill Street, and Jefferson Place. The neighborhood was first developed by the Brewer family in the early 1890's as a fashionable suburb of Annapolis; the crash of 1893, however, sent real estate prices plummeting, and the remainder of the lots were developed on a less pretentious scale. In the early 1900's Presidents' Hill was the home of many small

businessmen and craftsmen, including some who went on to become significant forces in the Annapolis commercial community. Two mayors of Annapolis lived in Presidents' Hill; another, current mayor of Annapolis Alfred A. Hopkins, has close family links to the community. The neighborhood began to change dramatically in the 1960's as the traditional family and social networks that held it together were eroded; the availability of Title 8 low-income housing funds led to a marked increase in rental property in the neighborhood. In 1984 Presidents' Hill was included in the Annapolis Federal Register Historic District, and it has increasingly become subject to gentrification over the last decade. This history will trace the chronicle of Presidents' Hill from its founding up to the present day, relying on interviews with long-time residents, newspaper accounts, and property records. A building-by-building survey of the community's architectural and historic landmarks will complement the narrative.

Journey of Olive King

Researcher: Professor David O. Tomlinson

The researcher has been editing this unpublished literary manuscript. Mrs. King and her husband took a year-long car trip across America in 1921. They pushed and cajoled an old Ford over the Rockies and back across the desert. Mrs. King has written a work which has literary interest. The manuscript is being edited for publication.

The Legacy of Tennyson's In Memoriam A.H.H., 1853-1900

Researcher: Associate Professor Eileen Tess Tyler

This is a long-term project. Its purpose is to determine the nature and extent of In Memoriam's influence upon English poetry between the time of its publication(1850) and the end of the Victorian period. Many of the works under investigation are neglected masterpieces. Others are of interest principally to literary historians and reception theorists and critics. This investigation involves categorization, contextualization, comparative and critical analysis, and study of the reception of the works of some twenty poets influenced by Tennyson's masterpiece.

Discernment in Victorian Literature

Researcher: Associate Professor Eileen Tess Tyler

This study examines the presentation of moral and vocational decisions in Victorian literature, and relates these literary renderings to their roots in the literature of Christian discernment. Tennyson's *Idylls of the King* and the fiction of Charles Dickens and Charlotte Bronte are deeply rooted in this tradition. Special attention is being given to the psychological dimensions of discernment--especially in the depiction of desolation and consolation--and to the angelic and demonic iconography associated with discernment.

Songs in the Night

Researcher: Professor John Wooten

The researcher has completed work on a novel, *Songs in the Night*. The novel is over 400 pages long. It is set in a small Southern town in the fall of 1966. It features two main characters who are called upon to solve a series of crimes that result in four deaths by the end of the story. Response has been very encouraging, and revisions have been undertaken to meet various criticisms.

Research Course Projects

The Evolution of Maine Coastal Humor

Researcher: Midshipman 1/C John F. Hussey III, USN
Adviser: Associate Professor Robert D. Madison

Among the effects of urbanization on traditionally rural regions, the alteration of local culture is, perhaps, one of the most profound. The seeming invasion of external culture into the folklore and traditional humor of the State of Maine is evidenced by both the differences between the generations of this genre, and the variations in performance and appreciation of traditional tales between rural and more urbanized regions of the state. Most obvious is the difference in focus. While the urbanites tend to focus on the quaintness of a storyteller and his or her story, those dwelling in rural areas are inclined to appreciate the fundamental wit expressed by native humorists and folklorists. By contrasting the original works of an early humorist, such as Holman Day, who lived around the turn of the century, and a contemporary storyteller, such as Tim Sample, the effects of time and urban versus rural sensibilities on Maine humor may be exposed.

Faeries' Ransom: Fiction Practicum

Researcher: Midshipman 1/C Andrea L. Lewis, USN
Adviser: Associate Professor Robert D. Madison

Modern "medieval" fantasy has become a genre unto itself. With archetypes which can be traced both to the Pre-Raphaelite and Victorian movements of the nineteenth century, it has produced both classic and cliche literature. Using examples from some of the masters in the field of medieval fantasy, such as J.R.R. Tolkien, C.S. Lewis, Sir Walter Scott, and Katherine Kurtz, this researcher wrote her own contemporary medieval fantasy work.

Centering around a proto-European geography, "Goswyn" utilizes both Mediterranean and Nordic landscapes. Characterization, however, is largely limited to northern European mythology in its combination of Celtic folklore and Anglo-Saxon medieval sociology. Challenges within this research included harmonizing these clearly Romantic characterizations with landscape description grounded firmly within the tradition of Realism.

The final project consists of three complete novel chapters and sketches for eleven other chapters and transitions.

Old Testament Influence on the Infancy Narrative of Matthew

Researcher: Midshipman 2/C Michael S. Mattis, USN
Adviser: Professor David O. Tomlinson

This project addresses the question of the literary influence of the Old Testament on the writing of the infancy narrative of the Gospel of Matthew. Specifically, this project focuses on the genealogy of Jesus, the use of images and archetypes to recall the Old Testament, and the use of specific Old Testament quotations in the infancy narrative of the Gospel of Matthew. The analysis includes a comparison of Matthew's genealogy of Jesus to both Old Testament genealogies and the genealogy of Jesus found in Luke, indicating that Matthew based his genealogy of Jesus on an Old Testament model. Investigation of Matthew's use of images and archetypes reveals the existence of parallel narrative structures between Old Testament themes and characters and the stories of Jesus' birth and infancy. Finally, examination of the question of Matthew's use of fulfillment citations suggests that the specific Old Testament quotations that Matthew incorporates into the infancy narrative are unrelated to their original Old Testament context.

Publications

BOOTH, Allyson, Assistant Professor, "Figuring the Absent Corpse: Strategies of Representation in World War I," *MOSAIC* (Fall 1992), 69-85.

This essay argues that the position of the corpse in the modern British imagination demonstrates how civilian modernists and Great War veterans together attempted to bridge the gap separating language from experience. Drawing upon a range of literary and non-literary sources and taking as its premise the interrelation between history and fiction, it suggests that what we think of as a distinctively postmodern self-consciousness about the distance between representation and experience is actually rooted in the geographic, imaginative, and political imperatives of the First World War.

BOOTH, Allyson, Assistant Professor, "To Caption the Absent Body: Marilynne Robinson's 'Housekeeping,'" *Essays in Literature* 19 (Fall 1992), 279-290.

This paper traces the narrator's quirky but painstaking inventory of textual models (travel brochures, the Bible, obituaries), artifacts (furniture, objects in a drawer) and images of intimacy (bones, pins)--all accumulated in her attempt to reconstruct relationships with family members she never knew or barely remembers. Gradually, this fragile but complex hoarding of images and captions emerges as a series of idiosyncratic but understandable narrative decisions: Ruth speaks because she wants both to explain her presence and to mark her absence. She abandons conventional "housekeeping" because the things she wants to keep are excluded by the boundaries of her house.

CLARIDGE, Laura, Associate Professor, *Romantic Potency.* Ithaca: Cornell University Press, 1992.

This book maintains that the extraordinary power of the male Romantic imagination stems in large part from the paradox that Romantic poets grounded their desire in the vicissitudes of language, a medium guaranteed to thwart their yearnings. The study draws on Lacanian theory to explore Romantic desire in relationship to the infant's radical yearning for an Eden before the advent of language. The Romantics attempt the impossible: to transcend the medium of words and reattain that original paradise of silence, but with their poetic voices intact.

ELLER, Jonathan R., Major, USAF, "The Stories of Ray Bradbury: An Annotated Finding List (1938-1991)," *Bulletin of Bibliography*, 49:1(March 1992), 27-51.

This finding list is designed to checklist and annotate Bradbury's American, Canadian, British,

and Australian story publications through the first fifty years of his career, and beyond (1938-1991). It includes the first complete listing of story appearances in magazines, magazine reprints, and Bradbury's own story collections, and identifies which stories evolve into (or from) other genres. These texts often show significant authorial revision, and represent the versions of his story texts over which he exercised authorial control. The researcher's purpose is two-fold: first, to provide a quick-reference finding list for readers who need to find a particular Bradbury story in any or all of its revised forms; and second, to offer researchers a focused record of the way that Bradbury has, over half a century, revised his stories, assembled and re-assembled his collections, and expanded his stories into novels, plays, screenplays, teleplays, and even musical theater.

The stories appear individually, arranged by date of first publication. For each story, the first publication entry is comprehensive and cross-referenced. An alphabetical index of all story titles, followed by an alphabetical index of all periodicals that have published Bradbury stories, concludes the finding list.

ELLER, Jonathan R., Major, USAF, and Professor, "Catching a Market: The Publishing History of Joseph Heller's *Catch-22*," *Prospects* 17 (1992), 475-525.

Heller's pioneering view of postwar America and his experiments with form and humor are perennial sources of literary criticism, but an equally fascinating story has never been told--the rise of *Catch-22* to market prominence in a culture where the novel of literary merit rarely survives a first printing. Understanding what makes this book an enduring part of our culture will remain incomplete until the publishing record becomes a part of the critical canon.

Catch-22 initially generated mixed reviews, and never achieved bestseller status in America. That Heller's views survived, and, in time, came to epitomize a new awareness among a new generation of readers can be traced in large part to fundamental changes in the way we publish and market literature in America. Changes in advertising strategy, in particular, helped Heller's controversial first novel stay alive in the East Coast book market until word-of-mouth praise(and overnight bestseller status in Great Britain) took it to national prominence. Within a year, the unprecedented publicity generated for the

hardbound edition of *Catch-22* propelled Heller into the middle of a revolution in paperback publishing, already underway, which served to introduce him--along with other innovative, postwar fiction writers--to the mass reading public. Dell's editors added wholesale availability and low paperback prices to the marketing scheme, and quickly turned the "Catch Cult" into the "Catch Craze." By the mid-sixties, this combination of new marketing strategies and the commitment of a number of agents, editors, and reviewers transformed momentary national prominence into enduring international popularity.

This article includes eleven archival illustrations.

ELLER, Jonathan R., Major, USAF, co-author, "A Plea for Interdisciplinary Scholarship," A supplement to *A GRAVITY'S RAINBOW Companion, Resources in American Literary Study*, 19:1 (1993), 94-106.

Steven Weisenburger's *A Gravity's Rainbow Companion* (Athens, Georgia: University of Georgia Press, 1988) is a much-needed reference for both teachers and students of Thomas Pynchon's encyclopedic 1973 novel. The *Companion* consolidates previously published glosses and goes on to identify many of the artistic and scientific allusions which remain untouched or partially recorded by Pynchon scholars. But the complex interdisciplinary weave of the work precludes any literary scholar, no matter how well qualified, from fully defining the novel without the partnership of scholars from other disciplines. This conclusion led a group of USAF Academy members to form, in the fall of 1986, just such a partnership to connect the interdisciplinary threads within the novel and to detect the allusive echoes which range across the entire spectrum of science, literature, and the arts.

Our partnership included faculty from English, History, Mathematics, Chemistry, Foreign Language, Behavioral Science, and Astronautical Engineering. Over the course of a single academic year, we pursued the allusions, recurring patterns, and the "red herrings" which surface in "Beyond the Zero," the first section of *Gravity's Rainbow*. Many of our glosses are based on Weisenburger's fine work in the *Companion*; but the advantage of multiple readership and multiple areas of expertise allowed our group to carry the discussion beyond the domain and perspective of the literary scholar. Our supplement will help both teachers and students move more rapidly into discussions of overall form and pattern in *Gravity's Rainbow*

patterns which will insure a thorough rather than fragmentary reading of the novel.

FLEMING, Bruce, E., Associate Professor, *Caging the Lion: Cross-Cultural Fictions*. New York: Peter Lang Publications, 1993.

This book-length study considers the ways in which one culture has perceived another as shown in the works of literature, dance, and film. It considers works by Ernest Hemingway, Charlotte Bronte, and Chinua Achebe, among others, in order to make the point that other cultures can be encountered in a manner that is neither appropriative nor masochistic on the part of the culture seeking the encounter. It traces the history of Western involvement with non-Western cultures from before the Romantics and concludes that this involvement is neither reprehensible in its own terms nor particularly fruitful for Westerners. This represents a challenge to current thinking on the topic of Western contact with non-Western cultures, which tends to see such contact in terms loosely derived from Marxist notions of cultural imperialism. The book situates this current thinking in the contemporary map of critical discourse, and proposes what it calls an alternative of "naive realism" to the other ways of dealing with the world outside currently available.

FLEMING, Bruce, E., Associate Professor, "Brothers Under the Skin: Achebe on Heart of Darkness," *College English*, (October 1992- February 1993), 90-99.

The Nigerian writer Chinua Achebe has criticized the Polish-English novelist Joseph Conrad for what Achebe finds to be the racism of Conrad's most famous novella, *Heart of Darkness*. The paper considers the validity of Achebe's accusation, and finds that though it is in fact well-founded, it is trivial. This is so because Achebe is using the same techniques in his own fiction which he brands as "racist" in Conrad's. The paper goes on to suggest that this is not a fortuitous congruence, rather that such techniques are common to all novelists, and that what Achebe is objecting to in Conrad are therefore not the techniques themselves but the particular use to which they are put. The paper suggests finally that we should be leery, as readers, of allowing contemporary sensibilities to color our reactions of historically situated texts such as Conrad's.

FLEMING, Bruce, E., Associate Professor, "On Becoming Human," *Sewanee Review*, 100.3 (Summer 1992), 410-420.

This paper is a personal essay in which the author recounts an experience he had while in Central Africa. The central situation involves a cat, which he was obliged to have euthanized. The situation is given weight and put in context by references to the bloody slaughter of meat eaten by humans in Central Africa, and by the cat's own carnivorous nature. The author thus concludes that in having the cat killed he has joined a circle of blood, that on which human life is ultimately based. It is for this reason that he suggests that in killing a domestic pet in a country where death is much more ubiquitous and closer to the surface in the West, he has somehow--as all people must do--"become human" as the title of the piece suggests.

FLEMING, Bruce, E., Associate Professor, "Do Real Men Watch Dance?," *Dance View*, 10:3 (Spring 1993), 45-48.

The piece is a consideration of the role of gender in the constitution of dance audiences in the United States, with particular focus on the classical ballet. It suggests that most men in the United States consider watching dance somehow unmasculine, and attempts to suggest reasons why this may be the case. It quotes theories of the film theoretician Laura Mulvey involving the power of the looker and the relative weakness of the looked-at to suggest that dance seems the most feminizing of all the arts for those who are involved in it. It engages in some historical speculation regarding the extent to which this attitude may be influenced by time and geography, and ends with a question: can this attitude ever change in the United States?

FLEMING, Bruce, E., Associate Professor, "On the Modern Full-Length," *New Dance Review*, 5.1 (July-September 1992), 20-22.

The article considers the difficulty of contemporary choreographers to mount evening-length pieces in the style of the classical ballet, using as it s examples a work by the British choreographer Kenneth Macmillan entitled "The Prince of the Pagodas" and a Japanese work entitled "The Mandala." It suggests that since the origins of the classical ballet were in the Romantic movement,

and since its plots typically involve fabular or unreal beings, it is particularly hard for choreographers with a more twentieth-century sensibility to work convincingly in this mold. While not attempting to be deterministic in its pronouncements, it is distinctly pessimistic regarding the possibility of making contemporary full-length works in this medium.

FLEMING, Bruce, E., Associate Professor, "Ritual Resurgent," *Ballet Review*, 20.2 (Fall 1992) 72-77.

The article begins with a consideration of the manifold of ways in which some form of ritual is cropping up on contemporary stages in the United Sates. It defines ritual action as action that seems purposeful and appears to be following a fixed order, but one whose purpose is unclear to the spectators. It equates the infusion of ritual in dance to the attempts of the Modernists to create their own form of movement, and traces the beginnings of ritual back to the pioneer Modern Dance choreographers, including Ruth St. Denis and Martha Graham. A lengthy analysis of Graham's "Primitive Mysteries" is offered. Finally, it suggests that the current interest in extra-European ritual from the rest of the world is an expression of this same Modernist impulse.

FLEMING, Bruce, E., Associate Professor, "Dance: The Case of the Missing Text," *Yearbook for Interdisciplinary Studies in the Fine Arts*, 3 (1992), 53-57.

This philosophical article considers the peculiar nature, in ontological terms, of dance as an art form. It suggests that the peculiarity of dance lies in the fact that it lacks, more than any other art form, what it calls a text. It defines this, and points to dance's traditional transmission mechanism of body-to-body replication. Even the existence of videotape and dance notation have not succeeded in giving dance a text, for these are records of particular performances and are not the means by which dance is transmitted. In making its argument the article calls upon the theories of Martin Heidegger and of the contemporary dance theoreticians Frances Sparshott and Jack Anderson.

JASON, Philip, Professor, *The Vietnam War in Literature: An Annotated Bibliography of Criticism*. Pasadena, California: Salem Press, 1992.

This research guide acquaints students with the wide variety of scholarship on Vietnam War Literature. After an introductory overview that treats critical trends and specialized library collections, the student receives assessments of key background readings in military and cultural history as well as other pertinent fields. This section is followed by one on general(multi-genre) literary studies, then one section each devoted to criticism of fiction, poetry, drama, and literary nonfiction. The final and longest section is an alphabetical arrangement of key Vietnam authors that provides comments on the critical writings about their works.

JASON, Philip, Professor, *Anais Nïn and Her Critics*. Columbia, South Carolina: Camden House, 1993.

This volume traces, describes, and assesses the body of critical opinion responsive to Anaïs Nin's writings from the 1930s to the present. The introductory chapter formulates the main critical issues of genre, intention, and affinity. Another chapter provides overviews of bibliographical, biographical, and comprehensive studies of essay length. Later chapters treat the commentary focused more narrowly on Nin's own critical writing, her short fiction, her novels, and her multi-volume *Diary*. The concluding chapter sums up the main trends in Nin criticism and attempts to understand them in terms of changing critical fashions as well as Nin's own growth as an artist.

JASON, Philip, Professor, "Issues in Nin Criticism," *Anais: An International Journal*, 11 (1993): 75-82.

The central issues concern the relative status of Nin's *Diary* and her fiction, the relationship between the two kinds of writing, and the contexts within which her critics can most profitably place her various writings. With regard to the fiction, critics debate whether it is most useful to assess each title individually or to view them as units in a career-long masterwork. Attention is also given to the issues developed in biographical and bibliographical research: Nin's own aversion to factual detail, the disguises and omissions in her diaries, and her chaotic publishing history make such efforts challenging yet fascinating.

MADISON, R.D., Associate Professor, ed., Eloise A. Saunders, *Sunnyacres: Early 1900's Life on a*

Woody Hill Farm, Westerly, Rhode Island, 1992.

Eloise (who was always impatiently embarrassed when addressed by anything other than her first name) assembled this memoir of subsistence farming in the early twentieth century from notes kept over a fifty-year period, and rewritten in this form over a span of twenty-five years. Eloise Abby Saunders was born on September 23, 1908 at Sunnyacres farm in Westerly, Rhode Island. The farm, three quarters of a mile from the Dunn's Corners end of the Woody Hill road, is known in old deeds as the Hall Farm.

O'BRIEN, Timothy D., Associate Professor, "Hemingway's 'Hills Like White Elephants,'" *The Hemingway Review*, 12.1 (Fall 1992), 29-36.

This study argues for a reexamination of what is readily accepted as the central conflict between different aspects of the natural setting described in Hemingway's short story. The conflict, in most accurate terms, occurs between the natural setting, on the one hand, and the artificial elements of the story's setting, on the other hand. The relationship between this conflict and the tension between the two characters of the story is enhanced, moreover, by a set of Biblical allusions from the dialogue.

O'BRIEN, Timothy D., Associate Professor, "Troubling Waters: The Feminine and the Wife of Bath's Performance," *Modern Language Quarterly*, 53.4 (December 1992), 377-390.

This essay examines the cultural values associated with the water imagery in the Wife of Bath's Prologue and Tale. It discusses how these values complicate our reading of the Wife of Bath as an object of Chaucer's criticism; they in fact support her as, in part, an authority. In uncovering these values, the piece examines the history of the city of Bath, literary sources such as Ovid, and patristic references to water and the feminine.

TINSLEY, Molly B., Professor, co-author, *The Creative Process*, New York: St. Martin's Press, 1992.

This text for teaching creative writing on an introductory college level breaks the process into three stages: generating material, exploring technique, and refining form. It relies heavily on its abundance of open-ended exercises as preliminary to all strong writing.

TOMLINSON, David O., Professor, "Bible," *The Mark Twain Encyclopedia*. ed. Lemaster and James D. Wilson. New York: Garland Publishing, Inc. 1993, pp. 72-77.

The article, a long one by encyclopedia standards, deals with Mark Twain's use of the Bible in his works. Sections deal with his practical approach to Biblical literature, his philosophical meditations about troubling Biblical teachings, his use of Biblical images and the pervasive influence of frontier religion on Mark Twain's writing. The article also includes a bibliography.

TOMLINSON, David O., Professor, "Calvinism," *The Mark Twain Encyclopedia*. ed. Lemaster and James D. Wilson. New York: Garland Publishing, Inc. 1993, pp. 118-122.

This rather lengthy article traces the influence of John Calvin's theology on the writings of Mark Twain. Twain may be said to have reacted against Calvin's teachings; and the article examines the reactions to basic tenets of the *Genevan Confession*. The article looks at Calvinistic and Twainian views of the following: (1) The Bible, (2) The proposition that there is only one God, (3) The belief that the law of God is alike for all, (4) The proposition that man is by nature blind and sinful, (5) The assertion that God makes all good, and (6) The belief that faith makes the gifts of God available.

The article includes a bibliography.

TOMLINSON, David O., Professor, "Colonel Sellers as a Scientist," *The Mark Twain Encyclopedia*. ed. Lemaster and James D. Wilson. New York: Garland Publishing, Inc. 1993, p. 166.

Mark Twain and William Dean Howells collaborated on a play about the most popular character from *The Gilded Age*. Though never produced, the play afforded the authors hours of delight and provided a fuss they never would have had otherwise.

TOMLINSON, David O., Professor, "Plasmon," *The Mark Twain Encyclopedia*. ed. Lemaster and James D. Wilson. New York: Garland Publishing, Inc. 1993, pp. 582-583.

Twain invested in numerous money-making schemes. Almost all of the investments ended badly. The investment in plasmon was no exception. Plasmon was a health food made from dried milk. Twain viewed it both as a personal way to wealth and as a cheap solution to the problem of world hunger. Unfortunately, the American public did not embrace the idea. Twain blamed Henry A. Butters, the head of the American corporation for the product for the failure.

WHITE, David A., Professor, "Ambrose Observes," *The Angelus*, monthly column, (June 1992-present).

Various subjects ranging from film reviews to religious questions to personal meditations.

WHITE, David A., Professor, *The Mouth of the Lion*, Kansas City: Angelus Press, 1993.

This book is a study of the life of Brazilian bishop Antonio de Castro Mayer and a history of his diocese of Campos, Brazil. Bishop de Castro Mayer was the only diocesan bishop in the Catholic Church who refused to make the changes that followed on the Second Vatican Council. The book is an examination of the man, his battle with Rome, and the results in the diocese.

Presentations

BOOTH, Allyson, Assistant Professor, "Battered Dolls," Popular Culture Association Conference, New Orleans, Louisiana, 10 April 1993.

BOOTH, Allyson, Assistant Professor, "Typewriters and the Rapidly Shrinking Self," Northeast Modern Language Association Conference, Philadelphia, Pennsylvania, 26 March 1993.

CLARIDGE, Laura, Associate Professor, "Shelley and Silence," International Shelley Bicentenary, Rostock, Germany, 2 October 1992.

CLARIDGE, Laura, Associate Professor, "Shelley and the Suppression of Beauty," NEH Shelley Bicentenary, New York Public Library, New York, New York, 22 May 1993.

DEKORNFELD, Thomas J., Lieutenant Commander, USN, "English and History Biennial Review." Presentation of xx11P subspecialty requirements to Designator Advisors at Navy Annex, Washington, DC, 13 April 1993.

FETROW, Fred M., Professor, "Phillis Wheatley and the Tradition of Benign Neglect," African-American Women Writers Section, Northeast Modern Language Association Convention, Philadelphia, Pennsylvania, 26 March 1993.

HILL, John M., Professor, "Rhetoric and the Subverted Mastery: the Loss of the Process and the Canon's Yeoman," New Chaucer Society Conference, Seattle, Washington, 5 August 1992.

HILL, John M., Professor, "The Social Milieu in *Beowulf*," Understanding *Beowulf*, Berkeley, California, 30 March 1993.

JASON, Philip K., Professor, "Anais Nin and the Burden of Self," Modern Language Association, New York, New York, 29 December 1992.

JASON, Philip K., Professor, "New Trends in Scholarly Publishing," Association of Independent Scholars, Washington, DC, 24 April 1993.

LEFCOWITZ, Allan, Professor, "Science Cannot Be A Higher Calling," Annual Conference of the Literature and Science Society, Atlanta, Georgia, 17 October 1992.

LEFCOWITZ, Allan, Professor, "How to Query a Publisher," Anne Arundel Writer's Association, Annapolis, Maryland, 24 October 1992.

LEFCOWITZ, Allan, Professor, "Publication Opportunities for Non-Academic Scholars," Society for Independent Scholars, Chevy Chase, Maryland, 25 April 1993.

MADISON, Robert, Associate Professor, "A Walk to Wachusett," The Thoreau Society, Princeton, Massachusetts, July 1992.

PARKER, Michael P., Professor, "Beastly Babes, Mute Messiahs: Millenarian Literature in the English Revolution," Conference on the Advancement of Learning in the Seventeenth Century, University of Sheffield, Sheffield, England, 6 July 1992.

PARKER, Michael P., Professor, "President's Hill, Past and Present," Annapolis History Consortium, Annapolis, Maryland, 2 January 1993.

TOMLINSON, David O., Professor, "Wieland, A Modern Abraham?" CEA-MAG Convention, Washington, DC 13 March 1993.

TOMLINSON, David O., Professor, "Wieland, A Modern Abraham," (Revised Version of the Essay), Northeast Modern Language Association Convention, Philadelphia, Pennsylvania, 27 March 1993.

History

Associate Professor Nancy W. Ellenberger
Chair

A gain this year, History faculty engaged in scholarly activity that embraced a wide range of subjects and approaches. Eighteen members of the department presented papers to scholarly audiences ranging from the American Philological Association to the Society for the Study of World War II and the Russian Academy of Sciences. Eight published major articles or book chapters, including work on 8th century holy relics, the anti-feminist aesthetics of Proudhon, the treaty-making strategies of King Alfred, Theodore Roosevelt's naval policy, electoral politics in colonial Virginia, the Navy's development of new technology in the 1870's, and the relationship between problems of linguistic ambiguity and biological evolution. Many others produced book reviews, encyclopedia entries, manuscript reviews, public lectures, and service to professional organizations.

After a spectacular year of book publication in AY91/92, the distinctive feature of scholarly activity this year was the acquisition of a number of competitive grants and awards. Three faculty members won NEH travel grants for archival work in the U.S. and abroad. Others received awards to work at Cornell University, the University of Arizona, the Virginia Historical Archives, and Frankfurt University in Germany. Associate Professor Robert Love and Assistant Professor Tom Sanders secured a Department of Defense Legacy Fund grant to investigate bringing copies of Soviet naval archives to a depository in the United States. Under the direction of Professor Phyllis Culham, a cross-disciplinary team including two other historians and two philosophers brought an unprecedented NEH institutional grant to the Academy to improve and integrate the teaching of ethics to midshipmen. Finally, Professor Craig Symonds was named runner-up for the prestigious Lincoln Prize, for his biography of Confederate General Joseph E. Johnston.

History faculty use their scholarly expertise and insight to create a dynamic intellectual life for the department and the midshipmen. Most engage in the faculty Works-in-Progress seminar and in workshops on development of the core history courses. Nearly all have directed the research of History Honors students or conducted specialized seminars for majors. Thus research in libraries and archives that is pursued in solitude makes a vital contribution to the continued learning of colleagues and students alike.

Sponsored Research

Alfred the Great: War and Kingship in Dark Age Britain

Researcher: Professor Richard Abels
Sponsor: Naval Academy Research Council (OMN)

This project examines the political thought of Alfred the Great, king of Wessex (871-899) through a careful study of the political vocabulary Alfred employed in his translations of works by Gregory the Great, Boethius, and Agustine. An analysis of these texts reveals that Alfred consistently glossed the originals in order to bring their conceptions of the political order into line with his own.

Historians of the post-World War II era have had a difficult time in reconciling Alfred "the simple, great-hearted warrior" (as one biographer has characterized him) with the philosophical Alfred of the Boethius and Augustine translations. But a study of Alfred's translations demonstrates that this dichotomy between Alfred the warlord and Alfred the seeker of wisdom is a false one. Alfred himself

made this clear in the preface to his translation of Gregory's *Pastoral Care*, in which wisdom is alliteratively portrayed as a precondition for both the wealth of a people and their success in war. Alfred's conception of his authority, powers, and duties as king fused contemporary ecclesiological and secular notions of rule. On the one hand, for Alfred, as for his immediate predecessors, to be king was to be, in the words of J. M. Wallace-Hadrill, "the channel, by grace, for the transmission of God's authority." On the other hand, to be king also meant to be a "lord and protector" of his people. A good king, according to Alfred, was a guardian of the common good; this meant not only maintaining peace and protecting the church, but also extending the king's rule over his neighbors. In short, Alfred's political thought was as much shaped by the heroic traditions of his native England as it was by the writings of Carolingian theorists.

The Sense of History at 8th- and 9th- Century Fulda

Researcher: Assistant Professor David F. Appleby
Sponsor: National Endowment for Humanities and Naval Academy Research Council (OMN)

This study considers the sense of history at the monastery of Fulda in order to advance our knowledge of the way early medieval Europeans understood the past. It focuses on the way the monks understood and wrote about their house's founder, Boniface, and Fulda's early years. The thesis is that the monks had a more vivid sense of history than has previously been acknowledged and that it was a key element of Fulda's communal ethos. The study is meant to suggest that the commonly accepted view, that 8th- and 9th-century people lacked any real sense of the past, is fundamentally misguided. This project is part of a larger monograph on the historical sense of people in the Carolingian era.

The Transformation of a Regional Market:
Early Modern Paris and its Hinterland

Researcher: Associate Professor Thomas Brennan
Sponsor: Naval Academy Research Council (OMN)

This is a large-scale study of the early modern French wine trade. It charts the structure and evolution of supply networks and the changing role of merchants and brokers in the national and international market through the end of the old regime. In particular, it focuses on the economic relationship developed between merchants and producers, on the use of debt and monopoly to achieve economic control. Through their use of credit and information, their control of related fields of transportation and containers, and their management of the financial system, they attempted to dominate both ends of the market network. The researcher will investigate these processes at an individual level, using cases provided by judicial and notarial archives. The study also addresses the issue of linkages between different levels of markets and the impact of dynamic growth at the national level on the function of local producers. This project has resulted in several scholarly presentations and an article accepted for publication.

Athens from 379 to 321 B.C.:
The Navy, Domestic Politics and Foreign Policy

Researcher: Instructor Michael Clark
Sponsor: Naval Academy Research Council (OMN)

The second period of Athenian naval pre-eminence, during the fourth century B.C., has attracted far less attention among historians than the much-studied fifth century Athenian Empire. Reasons for this scholarly neglect are many and complex. Certainly one prominent factor has been the absence of a political/military history of Athens in the fourth century of the calibre of Thucydides' famous account of the fifth century. Nevertheless, there is no lack of fourth century evidence to be studied. Indeed, the great variety of evidence presents a range of difficulties that few historians are prepared to address. Issues connected with the role and function of the Athenian Navy and Athenian foreign policy seem to be central to any history of this period. It happens that many Athenian inscriptions surviving from this time preserve partial inventories of the naval administrators. Expertise in inscriptions may provide keys that can begin to unlock the doors on what has been until now a particularly obscure field.

Throughout the fourth century Athens apparently attempted to resurrect the Empire she had lost at the end of the fifth century. The extensive evidence concerning the expansion of Athens' fleet over this entire period, therefore, is crucial to our understanding of the political background of major events of the fourth century B.C. It would be very useful in trying to understand Athenian foreign policy to have accurate and comprehensive information concerning the size of the fleet at each stage of the fourth century. Growth, stagnation or collapse in the shipbuilding program at any particular time might indicate much about Athenian goals and resources.

This research will lead directly to several articles and eventually also to the full republication of the Athenian naval inscriptions.

Cooperative Education in the Western Civilization Classroom

Researcher: Professor Phyllis Culham
Sponsor: Naval Academy Instructional Development Advisory Committee

In the last decade, numerous studies have demonstrated that the lecture is the least successful teachin method, whether measuring short-term retention, long-term retention, or ability to apply the methodology to new problems. Cooperative work on tasks in small groups gets the best results, especially as measured by the latter two criteria. This method is uniquely suited to the teaching of values and ethics, since it allows the student to work through a set of choices. This project will develop ways for applying cooperative education methods to the new, required emphasis on ethics and values in the western civilization core sequence, HH205 and HH206.

A Roman module was worked up for HH205 which centered upon Tacitus' *Agricola*, the most frequently used Roman book in the course. Material on contrasting values and ethics of the Roman Republic with those of Tacitus' era, a model in-class cooperative learning exercises, as well as a model writing exercise on *Agricola*, transparencies on Britain in the era of the *Agricola* and handouts on interpretive quizzes and cooperative evaluation were all part of the project development.

A People Go to War: The Virginia Homefront, 1860-1865

Researcher: Associate Professor Mary DeCredico Griffin
Sponsor: Naval Academy Research Council (OMN)

Historians of the American Civil War have examined many facets of the Confederate experience. Recently, scholars of Southern history have turned to the social, economic, political, and military aspects of civilian life "behind the lines." These studies have concentrated upon the homefront in an effort to understand how the civilian population adapted to the hardships of war and enemy invasion. This work will contribute to that growing body of literature by analyzing the state of Virginia. Particular attention will be paid to the urban economies at war, poor relief, the plantation and slavery, and the course of morale and general support for the war effort within the state. Virginia is particularly worthy of study because it housed the Confederate capital and some of the South's most important industrial establishments. This proposed project, which should produce a book, will add to our understanding of the effect of the war on the South's civilian population.

Soviet-Russia Navy Archive Project

Researchers: Associate Professor Robert W. Love and
Assistant Professor J. Thomas Sanders
Sponsor: Department of Defense, Legacy Program

This research project aims to study the need for and feasibility of establishing a center in the West dedicated to the exchange of Cold War naval documentary and film records on the Soviet and Russian Navies. The project also aims to support the arrangement of formal sharing agreements with Russian archives holding Soviet naval documentation and to encourage scholarship in the United States in the study of the Soviet Navy.

Unwanted Immigrants: The Japanese in Latin America, 1890-1950

Researcher: Associate Professor Daniel M. Masterson
Sponsor: Naval Academy Research Council (OMN)

This project is now under contract with Paragon House Publishers of New York and will be a 300-500 page monograph to be published in 1995. It is being co-authored with John F. Bratzel of Michigan State University and Sayaka Funada of Kobe University in Japan. Based upon research in six Latin American countries and numerous archives and libraries in the United States, it will examine the immigration and settlement of migrants from rural southern Japan and Okinawa during the late 19th and early 20th century to Latin America. Patterns of community development, economic advancement and race relations with the diverse peoples of Latin America will also be examined for the period from 1920 to 1950.

The Illuminating Mind in Twentieth-Century American Photography

Researcher: Associate Professor David P. Peeler
Sponsor: Naval Academy Research Council (OMN)

This project is an examination of the growth of American photography in the twentieth century. It explores the ideas and values of leading American photographers, and the ways in which they brought those beliefs and values to fruition in their work. The project fills a gap in the existing scholarship, for while there is a substantial body of art criticism on the medium, there is little substantial scholarly treatment of the ideas associated with this broad swath of creative photography. My principal question is this: in what ways did these creative individuals seek to resolve the tension that arose from working in a medium with an almost worshipful attitude toward objectivity, while daily seeing the evidence in their work that even the simplest fact cannot be presented without altering its "pure" objectivity in some way?

This project was also supported by the Center for Creative Photography at the University of Arizona.

The Social Function of Dissertation Defenses in Late Imperial Russia

Researcher: Assistant Professor J. Thomas Sanders
Sponsor: Naval Academy Rresearch Council (OMN)

During a period as a Visiting Scholar at the Hoover Institution on a State Department Title VIII grant, the researcher discovered a previously unexplored realm of elite social life in late imperial Russia: the dissertation defense. These, it turned out, were gala public affairs whose social role was to affirm the class position of the educated elite vis-a-vis both the government and the lower classes. An article based on this research has been accepted for publication by the *Jahrbuecher fuer Geschichte Osteuropas*.

Hegel's Map of the Imagination

Researcher: Assistant Professor Chip Sills
Sponsor: Naval Academy Research Council (OMN)

The purpose of this project is to develop an original theory of imagination based on a study of Hegel's *Science of Logic* understood as a systematic development of a new idea of "Concept"--an idea which includes the notion of "trope." At issue is the relationship between logical and poetic modes of construing evidence. Scheduled for research this summer are medieval notions of the tropological which may include a specific *ethical* twist. Study will ascertain whether Hugh of St. Victor's notion of the tropological--cited by Thomas Aquinas in his *Summa Theologiae*--extends to cover the notion of "conversion" or "periogoge" or "metanoia," terms which have historically included religious or philosophical senses of turning towards the good.

Ramus and Reform: The End of the Renaissance and the Origins of the Old Regime in France

Researcher: Assistant Professor James V. Skalnik
Sponsor: Naval Academy Research Council

The educator and reformer Peter Ramus (1515-1572) made great efforts to defend the relatively open and meritocratic society of Renaissance France against the spread of Old Regime ideas and institutions, beginning in the middle of the sixteenth century. As a leading figure in both the French Reform and the University of Paris, as well as the author of the pedagogical system known as "Ramism," he consistently promoted an ideology that would make status, influence, and authority dependent on talent and achievement, rather than on birth, wealth or cooptation by existing elites. His social ideal, which he eventually labelled "timocracy," attracted a sizable following and achieved some practical results during his lifetime. After his death in the St. Bartholomew's Day Massacre of 1572, however, his ideology fell out of favor and his reforms collapsed. In their place arose the hierarchical, oligarchic, and authoritarian society of Old Regime France.

This investigation is significant beyond the narrow focus of Ramism itself. It helps to illuminate the collapse of the Renaissance ideal in France and the spread of institutions and ideas typical of the Old Regime.

Religions and Politics in Iran, 1725-1750

Researcher: Assistant Professor Ernest S. Tucker
Sponsor: Naval Academy Research Council (OMN)

Between 1720 and 1740, two rulers of Iran, the Afghan Shah Ashraf and Nadir Shah, both wrote letters to the Ottoman sultan which, in essence, asked him to confirm them as the legitimate Sunni rulers of Iran. Both Ashraf and Nadir might have expected the Ottomans to welcome such pro-Sunni overatures, but they categorically rejected both proposals. This project was designed to address the issues of why Nadir and Ashraf advanced such offers and why the Ottomans ultimately rejected them. It is based on correspondence between Iranian and Ottoman rulers of the period, as well as relevant documents from the Ottoman State Archives.

Robert NcNamara: A Biography

Researcher: Assistant Professor Brian VanDeMark
Sponsor: Naval Academy Research Council (OMN)

Robert McNamara influenced the Pentagon more than any other Defense Secretary since World War II. His mark on the Department of Defense--whether applauded or decried--was broad, deep, and lasting. After Presidents Kennedy and Johnson, McNamara shaped the course of U.S. policy in the Vietnam War more than any other single government official. His impact on the history of the turbulent, decisive 1960's is clear and profound. A figure of such importance deserves--arguable demands--careful, dispassionate scholarly attention and analysis. This project aims to produce a thorough, balanced biography of this major figure in recent American history.

The Quantum Revelation

Researcher: Midshipman 1/C David K. Ismay
Adviser: Professor P. Robert Artigiani
Sponsor: Trident Scholar Program

This project examined the nature of the epistemological change associated with the discovery of quantum physics in the early twentieth century. Examining the writings of key scientists associated with the movement, it concluded that quantum physics did not represent a revolutionary change over Newtonian physics in the way scientists viewed the universe. It convinced these scientists that the ability of their vocabulary to describe nature was limited, but not that the underlying premises with which they approached the universe were wrong. A portion of this work was written as part of the Honors program in the history major, while the full work completed requirements for the Trident Scholar Program.

Independent Research

Dictionary of Admirals of the United States Navy, Volume III, 1919-1941

Researcher: Associate Professor William B. Cogar

This research will produce the third of what will be a multi-volume series on all admirals of the United States Navy. This volume will be a continuation of the first and second volumes which covered the years 1862 through 1900, and 1901 through 1918. Like its predecessors, this volume includes biographical and career information, as well as bibliographical information. The intent is to provide the world of scholarship with a reliable and convenient source on American admirals which at present does not exist. This volume will be published by the U.S. Naval Institute Press.

An Encyclopedia of Naval History

Researcher: Associate Professor William B. Cogar

The Encyclopedia will provide a complete guide to world naval history from the fifteenth century, the beginnings of the age of sail and of the gun, to the present day, ending with two contemporary wars, the Iran-Iraq War and the Persian Gulf War. With over 1000 entries, arranged chronologically, it will be the most comprehensive work of its kind on the market. The researcher serves as a senior editor to the naval biography section. This volume will be completed in early 1994 and published by "Facts on File, Inc."

Roman Records

Researcher: Professor Phyllis Culham

Roman history to date has over systematized the fragmentary evidence for Roman law and administration. New anthropological work on premodern societies' use of writing allows us to re-envision the Roman past. The project will result in completion of a book manuscript.

Shield of the Republic: The United States Navy in an Era of Cold War and Violent Peace

Researcher: Associate Professor Michael T. Isenberg

This two-volume work will present a history of the U.S. Navy since the end of World War II. Already accepted for publication, the first volume will appear in 1993.

Educational Responses to Tailhook

Researcher: Professor David E. Johnson

The events that occurred at the meeting of the Tailhook Association in September 1991, raise serious ethical and educational issues. Of particular concern to an officer accession source like the Naval Academy is what type of educational efforts can be made with our students to reduce the likelihood of a repeat of the Tailhook incidents. Addressing that concern is influenced by descriptions of what occurred at Tailhook. If these events are merely "boys will be boys" as some alleged, a different type of education might be called for than if these events are the result of deep seated misogyny. This project collected and analyzed varied descriptions of what occurred at Tailhook, drawing particularly on Part I of the tailhook report of the IG of the Pentagon. Based on these descriptions various educational responses are proposed.

Elections and the Political Communities of Colonial Virginia, 1728-1775

Researcher: Assistant Professor John G. Kolp

Elections to the eighteenth-century Virginia House of Burgesses have been of long-standing interest to historians because of the role they played in the early political careers of a number of America's Founding Fathers. Although these men were selected for office within their local county constituencies by a substantial proportion of the adult male population, it has never been clear what meaning should be attached to these political events. What did this selection process prove? Was there any real difference between candidates? Were these events merely social gatherings or was something important being decided at these elections?

In this work, a number of themes emerge from detailed case studies of three counties, including the importance of tenants in the election process, the broad spectrum of issues colonial voters thought germane, the remarkable stability of voting behavior, the importance of previous officeholding to candidate success, and the role of local neighborhoods in defining electoral choice. In addition, examination of surviving data on all elections for this period reveals a pattern of gradual

decrease in electoral competitiveness over the 50-year period, but also demonstrates substantial regional variation which does not fit traditional interpretations. The study will produce a monograph for publication by the Johns Hopkins University Press.

Discovering the Signs: Social Images of the Deaf Community in Nineteenth Century France

Researcher: Associate Professor Anne T. Quartararo

This research project is a synthetic study of the social and cultural forces that created the deaf community in nineteenth century France. The researcher is focusing on the emergence of a deaf identity during a period of intense social change in western society. In the first part of the study, the revolutionary period is placed in perspective. The researcher is studying the concept of social deviance in terms of charity and public assistance. In the second part of the project, the researcher is studying the emergence of deaf community associations, initiatives for deaf education and the role of leading activists to improve the condition of deaf people. In the third part of the study, the researcher is looking at the uses of language and the exclusion of sign language from schools that educated the deaf in the late nineteenth century. In addition, the role of deaf-run congresses, deaf associations and newspapers will be analyzed to understand the emergence of deaf culture. The researcher has recently published a study of the deaf activist, Henri Gaillard.

The Origins of the Modern American General Staff

Researcher: Associate Professor William R. Roberts

Previous historians have argued that the American General Staff was patterned after the Prussian General Staff in order to make the American army a more effective fighting force. This research, however, has lead to the conclusion that the staff reforms introduced at the beginning of the twentieth century represented the culmination of a long-standing struggle for power between line and staff officers as well as another struggle for power between the secretary of war and the nineteenth-century commanding general. Supporters of the creation of the General Staff in 1903 wanted to strengthen the secretary and the line as much, if not more, than they wanted to improve the fighting skills of the army. Their reforms provided a foundation for the growing bureaucratization of the military establishment in this century. The final product of this research is to be a monograph already accepted for publication by Greenwood Press.

University and Ideology in Sixteenth Century France

Researcher: Assistant Professor James V. Skalnik

Dramatic changes in the economic and social order in France in the mid-sixteenth century prompted equally dramatic changes in the nature of the University of Paris, Europe's leading educational institution up to that time. Previous research has established the extent to which policies on faculty recruitment, admissions, and financial aid to students altered to reflect the new social realities. To complete our picture of an early modern university in transition, it is necessary to investigate changes in the official ideology of the university, as revealed in its mandated curriculum as well as in its relationships to the reformed Catholic Church and to the emerging absolute monarchy of France.

A Topical History of the Third Reich

Researcher: Professor Larry V. Thompson

Research is being conducted for a book-length synthesis of National Socialist Germany. Topically organized, the study is both interpretive and derivative. It seeks to demonstrate the experience of everyday life under National Socialism while documenting the extent of polycratic rather than dictatorial rule exhibited by the regime. Based upon extensive archival research and current scholarship over the past quarter century, the book, when completed, will contribute to the continuing scholarly debate on whether or not the Nazis were functionalists or intentionalists in program and practice.

Research Course Projects

"A Dangerous Man": The Border State Dilemma and Major General Isaac Ridgeway Trimble, C.S.A.

Researcher: Midshipman 1/C Eric J. Bach, USN
Adviser: Professor Craig L. Symonds

The American Civil War has often been characterized as a war of "brother against brother," and often this was quite literally the case. Such fraternal strife was particularly evident in the border state of Maryland. One man who personified the dilemma of the border states--caught between local and national loyalties--was Isaac Ridgeway Trimble, a Marylander who ended up fighting for the Confederacy and who led one of the rebel divisions in Pickett's Charge at Gettysburg. But Trimble's decision to "go South" was not the result of deep thought or careful consideration. Indeed, it was not even voluntary. Charged by Maryland's governor to keep peace in the volatile days following the Baltimore riots, Trimble's role in that episode was subsequently viewed by the national authorities as insufficiently patriotic, and an order for his arrest issued. When Trimple learned that he was a wanted man, he headed South and offered his services to the Confederacy. Trimble's tale reveals a great deal about Maryland politics, local loyalties within the state, and the national mood in the opening days of the American Civil War.

Leopold Sedar Senghor and Negritude: Establishing an African Identity

Researcher: Midshipman 1/C Maria L. Grauerholz, USN
Adviser: Assistant Professor Samuel H. Nelson

Leopold Senghor of Senegal is generally acknowledged as the father of "Negritude," a cultural movement whose primary goal was the reconstruction of an African social identity following decades of destructive and demeaning colonial rule. This paper explored Senghor's motives and philosophy through a careful and detailed analysis of his poetry. It discovered and highlighted key literary themes and cultural symbols which were used to reinstill in the African intelligentsia a sense of pride in their traditional ancestry and culture. The paper concluded with a survey of how other African writers and intellectuals have assessed the motives and means of Senghor's literary achievements.

An Incident at Cam Ne

Researcher: Midshipman 1/C Christopher T. Graves, USN
Adviser: Associate Professor William R. Roberts

Critics of the media often accuse the press of sabotaging the American commitment in Vietnam. This project explores an early example of reporting sometimes cited by media critics--Morley Safer's coverage of the burning of Cam Ne by U.S. Marines. The researcher discovered after careful analysis of Marine, Vietnamese, and press accounts that Safer's report was not the effort of an anti-war reporter determined to discredit the Marine Corps. His research refutes the claims of Robert Elegant and others who have accused Safer of staging the scenes in order to undermine American participation in Vietnam. Working under trying circumstances, both Safer and the Marines inadvertently made mistakes that transformed what began as a routine operation into one of the most striking and controversial views of the war shown on television. Understanding how Safer's report evolved lends insight into the study of television and the military in Vietnam.

Eisenhower with the British: A Study in Coalition Command

Researcher: Midshipman 1/C W. Spencer Johnson, USN
Adviser: Professor John W. Huston

This study examined the role of Dwight D. Eisenhower, Supreme Commander of Allied Expeditionary Forces in Europe, from the invasion of the continent through the Battle of the Bulge. The emphasis was upon Eisenhower's talents in dealing with our major ally, Great Britain, in keeping together a coalition which underwent a major change. The new relationship involved the transition of the United States from a minor player in Europe to the major component of the invasion force and the appreciation of the declining role of Britain. The study analyzed the relationships of Eisenhower with the British and American senior military staffs and political leadership. Particularly difficult was the relationship with General Montgomery and the effort to retain the unity required for success, in view of the perception of Montgomery's slowness and seeming reluctance to commit his forces with the same degree of force as other armies.

Liberation and Reform in Peru: The Catholic Church and Social Change

Researcher: Midshipman 1/C James A. Lenart, USN
Adviser: Associate Professor Daniel M. Masterson

This project examines the evolution of the social reform movement within the Catholic Church in Latin America during the 1960's, with particular emphasis on Peru. As background to the discussion of the "Liberation Theology" movement which began in Peru with the leadership of Father Gustavo Guttierez, church-state relations since the Spanish Colonial era are carefully reviewed. The focus of the paper is the social reform initiative of the Latin America Catholic bishops following the Medellin, Colombia Church Conference of 1968. Church-sponsored reform in Peru coincided with the nationalist and populist reform policies of the military government of General Juan Velasco Alvarado and this nexus is closely analyzed. Finally, the institutional implications of radical reform policies within the Catholic Church and the Peruvian military are examined.

The Historical Significance of the Battle of Agincourt

Researcher: Midshipman 1/C Robert S. Peterson, USN
Adviser: Professor Richard P. Abels

The popular conception of Agincourt, immortalized in Shakespeare's play *Henry V*, is that the young Henry V achieved a decisive victory over the French chivalry on St. Crispin's Day in 1415. Historians, while acknowledging the English victory, have been less certain as to the military significance of the engagement. The present study represents a careful examination of the primary and secondary source evidence on Agincourt and Henry V's military campaigns. On the basis of this evidence the researcher concluded that Agincourt's importance had less to do with its weakening of the French ability to resist Henry militarily than with the religious and psychological import that the battle had for Henry V. Agincourt may not have laid Normandy open for conquest, but it gave Henry the resolve to plan the invasion of Normandy in 1417. For a young king whose legitimacy was tainted by the manner in which his father had obtained the throne, Agincourt was no less than a judgment by God that Henry was the rightful king not only of England but of France.

Development in Command: General George Washington's Military Talents and His Relations with Foreign Officers 1777-1781

Researcher: Midshipman 1/C Craig C. Wirth, USN
Adviser: Professor John W. Huston

This honors thesis examined General George Washington's relationship with foreign officers during the American Revolution concentrating on the period following Lexington and Concord and continuing through the battle of Yorktown in 1781. The emphasis was on Washington's dealings with French officers both before and after the formal alliance with France which was signed in February 1778. The bulk of the research was in primary source material using the extensive writings and diary of General Washington and the records and debates of the Continental Congress. Included in the paper was an assessment of the impact of Washington's relations with Lafayette, Rochambeau, the officers involved in the Conway Cabal and several non-French foreign officers.

Publications

ABELS, Richard P., Professor, "King Alfred's Peace-Making Strategies with the Vikings," *The Haskins Society Journal: Studies in Medieval History*, 3 (1992), 23-34.

King Alfred's attempts to make peace with the Vikings became a leitmotif of his reign. The methods that he chose reflect both changes in his and his enemies' circumstances and in his understanding of the threat the Vikings posed to him and his kingdom. As in other aspects of his reign, Alfred's peace-making strategies force us to reconsider the received view of the king as an "earnest, kindly, simple" man. From his dealings with the Vikings Alfred emerges as a flexible, pragmatic, and, when the occasion demanded, even ruthless warrior king, whose Christian piety did not preclude him from attempting to bind the heathens by means of a pagan ritual. The difficulties that Alfred experienced in making peace with the Vikings also call into question whether Christian Anglo-Saxon kings and pagan Viking sea-kings shared a common political culture and held the same concept of 'peace.'

APPLEBY, David F., Assistant Professor, "Holy Relic and Holy Image: Saints' Relics in the Western Controversy over Images in the Eighth and Ninth

Centuries," *Word & Image*, 8 (October-December 1992), 333-343.

This article addresses one aspect of the controversy over the use of religious images in Italy and France in the later 8th and 9th centuries. It argues that once the quarrel over images began, the question of the western custom of venerating the physical remains (relics) of saints became as powerful a motive for participants as the question of the use of religious images in worship. It concludes that the veneration of relics gave the controversy a peculiarly western flavor, and that future scholarship would profit from a consideration of the relationship between holy objects and religious art in the early Middle Ages.

ARTIGIANI, P. Robert, Professor, "Image-Music-Pinball," *Modern Language Notes* 107 (1992), 855-76.

The relationship between problems of linguistic ambiguity and biological evolution are examined.

ARTIGIANI, P. Robert, Professor, "From Epistemology to Cosmology," eds. E. Laszlo et al., *The Evolution of Cognitive Maps*. New York: Gordon & Breach, 1993, pp. 29-60.

The revolution in scientific concepts associated with the quantum and dissipative structures theories is examined.

CULHAM, Phyllis, Professor, "Recovering Feminist Aesthetics by Reading a Reaction on the Left," *Politics, Gender, and the Arts*. Susquehanna, Pennsylvania: Susquehanna University Press, 1992, pp. 19-31.

Proudhon's extreme antifeminist and misogynist reaction to paintings by his female contemporaries actually highlights some characteristics of those paintings which deserve more (and more friendly) attention. Female portrait painters of the early nineteenth century in France were actually attempting to assert their equality to male "history" painters and were purveying an actively feminist ideology.

CULHAM, Phyllis, Professor, "Plutarch and the Primacy of Science over Technology," *Plutarco e le Scienze*. Genoa: University of Genoa Press, 1992, pp. 179-197.

Plutarch's treatment of Archimedes in the *Life of Marcelles* is meant to denigrate technology, particularly military technology, and to laud the study of "pure" mathematics and science. Plutarch's attitude is part and parcel of his Platonism. This attitude among Greek intellectuals is the real barrier to scientific accomplishment in the Greco-Roman world, since it discourages the study of instruments and measurement.

ELLENBERGER, Nancy W., Associate Professor, "Sir William Vernon Harcourt" and "Charles Whibley," ed. G. A. Cevasco, Ed., *The 1890s: An Encyclopedia of British Literature, Art and Culture*. New York: Garland, 1993, pp.

Charles Whibley (1859-1930) was a British journalist, literary critic, and essayist whose long career at the center of the London publishing world brought him into contact with a generation of writers, including H. G. Wells, Rudyard Kipling, and W. B. Yeats, who transformed English prose style in the late 19th century. Sir William Harcourt (1827-1904), statesman and politician, was one of the most important figures in the Liberal Party during the second half of Victoria's reign. His long career culminated in the 1890's, when he served as Gladstone's chief lieutenant in the House of Commons. Harcourt's rivalry with Lord Rosebery for leadership of the Liberals after Gladstone's retirement divided the party throughout the decade, and contributed to its inability to provide more than a brief interlude to twenty years of Conservative party rule.

HARROD, Frederick, Professor, "Managing the Medium: The Navy and Motion Pictures before World War I," *The Velvet Light Trap*, 31 (Spring 1993), 48-58.

The U.S. Navy was an early and enthusiastic user of motion pictures. As early as 1904 the service showed motion pictures as a part of its exhibit at the St. Louis World Fair, and by 1906 the department took steps to make its own films to support its recently-begun efforts at inland recruiting. The Navy soon discovered, however, that it wished not only to make its own films but also to control the image of the Navy in commercial entertainment films. By controlling access to Navy installations they achieved considerable success in controlling the way the film industry portrayed the service.

HARROD, Frederick, Professor, "New Technology in the Old Navy: The United States Navy during the 1870's," *American Neptune*, 53 (Winter 1993), 5-20.

Naval historians often brush the decade of the 1870's aside as an era of technological stagnation and general decay within the service. A closer examination, however, reveals that within limited resources the Navy actively pursued new technology. Representative of this official interest was the opening of the Newport Torpedo Station, a facility which as part of its duties functioned as a research and development laboratory for explosives, torpedoes, and electricity.

KOLP, John G., Assistant Professor, "The Dynamics of Electoral Competition in Pre-Revolutionary Virginia," *William and Mary Quarterly*, 94 (October 1992), 652-675.

While most research on local politics in colonial Virginia has portrayed the system as static, uniform, and virtually unchanging from 1725 to 1815, this study asserts that the electoral system should be viewed as a dynamic entity responding to temporal change and to local, regional, provincial, and imperial influences. To test this assertion, every scrap of evidence on all 882 general and by-elections held between 1728 and 1775 is subjected to detailed quantitative analysis to determine the trends in electoral competition over time and the potential differences between counties and regions of the colony. Only about one-third of the elections held during this period are found to be competitive. Findings also suggest a general downward trend in electoral competitiveness over the period, as well as considerable diversity between sections of the colony that do not fit previous geographical models.

LOVE, Robert W. Jr., Associate Professor, *1941-1991*, Vol. II of *History of the U.S. Navy*. Harrisburg: Stackpole Books, 1992.

Rejecting the older, untenable "Command of the Sea" and "Sea Power" thesis, Volume II argues that international politics, domestic partisan politics, and the state of technology formed the bases of American naval policy and strategy in the Second World War, the Cold War, and at the dawn of the New World Order. Volume II contends that U.S. Navy participation in the coalition warfare of 1941-1945 drew to an end a long era during which the United States acted as the arbiter of the Balance of Power in Europe and Asia. During the Cold War, the United States found itself the Global Bailiff, responsible not only for maintaining the uneasy strategic balance with the Soviet Union but also for upholding order, democracy, and capitalism in areas in which the bipolar competition was only marginally relevant.

LOVE, Robert W. Jr., Associate Professor, "Fleet Admiral Ernest J. King," ed., Stephen Howarth, *Men of War: Naval Leaders of World War II*. London: Weidenfeld and Nicholson, 1992, pp. 75-107.

Aimed largely at an English audience, this interpretation of Admiral King's 1942-1945 tenure as Chief of Naval Operations/Commander in Chief of the U.S. Fleet deals extensively with his Allied naval diplomacy regarding the Second Front, the Battle of the Atlantic, and British participation in grand strategy in the Pacific and Asian mainland campaign against Japan. Among other things, the essay demonstrates that the Battle of the Atlantic was largely a pseudo-crisis resulting from uneven or misguided British policy and grand strategy.

LOVE, Robert W. Jr., Associate Professor, "Theodore Roosevelt and Naval Policy, 1901-1909," eds. John Gable, et. al., *Theodore Roosevelt and Modern America*. Westport: Greenwood Press, 1992, pp. 317-328.

This article, the first reevaluation of Theodore Roosevelt's naval building policy in two decades, argues that the President failed to link his naval policy with overseas crisis or specific foreign policy objectives and, more often than he later cared to admit, frequently provided Congress with little guidance as to the aims of his building programs. The article depicts TR not as the mythic statesman of seapower, but as overconfident, inconsistent, and often reactionary.

VANDEMARK, Brian, Assistant Professor, contributions to Leonard W. Levy and Louis Fischer, Eds., *Encyclopedia of the American Presidency*. New York: Simon & Schuster, 1993, pp.

The author contributed entries on the Bretton Woods Agreement, Destroyer Deal, Good Neighbor Policy, Cordell Hull, Japanese Peace Treaty, Pearl Harbor, Potsdam Conference, and Vandenburg Resolution.

Presentations

APPLEBY, David F., Assistant Professor, "'Things Seen and Things Heard' in the Pastoral Thought of Bishop Jonas of Orleans," 28th International Congress on Medieval Studies, Kalamazoo, Michigan, 7 May 1993.

ARTIGIANI, P. Robert, Professor, "Prigogine and the Contemporary Revolution in Science," Chesapeake Biological Laboratory, Solomons Island, Maryland, 3 November 1992.

ARTIGIANI, P. Robert, Professor, "Entropy and Social Progress," Interdisciplinary Conference, University of South Dakota, Vermillion, South Dakota, 9 November 1992.

ARTIGIANI, P. Robert, Professor, "Emergence as a Scientific Concept," Evolutionary Systems Conference, Washington, DC, 18 January 1993.

ARTIGIANI, P. Robert, Professor, "Saving Us from Ourselves: Evolution Theory and the Societal Auto-Immune System," First Brandenburg Colloquium for Evolutionary Thinking, Potsdam, Germany, 29 May 1993.

BRENNAN, Thomas E., Associate Professor, "The New Rome Revisited: Delamere and LaReynie," Conference of the Society for French Historical Studies, Chico, California, 20 Marcfh 1993.

BRENNAN, Thomas E., Associate Professor, "Merchants and Middlemen in the Eighteenth-Century Wine Trade," Conference of the American Historical Association, Washington, D.C., 30 December 1992.

CLARK, Michael G., Instructor, "New Findings on Old Ships," Annual Meeting of the American Philological Association, New Orleans, Louisiana, 28 December 1992.

CULHAM, Phyllis, Professor, "The Status of Women in the Roman Empire," Conference on Feminism and the Classics, University of Cincinnati, Cincinnati, Ohio, 25 October 1992.

CULHAM, Phyllis, Professor, "The Archimedes Digression in the Life of Marcelles," Annual

meeting of the American Philological Association, New Orleans, Louisiana, 28 December 1992.

ELLENBERGER, Nancy W., Associate Professor, "Balfour, Curzon, and Vita Sackville-West: Observations on Gender and Power in *All Passion Spent*," Annual Meeting of Mid-Atlantic Conference on British Studies, New York, New York, 2 April 1993.

GRIFFIN, Mary DeCredico, Associate Professor, "The Urban Economy at War: Richmond War Relief, 1861-1865," Organization of American Historians, Anaheim, California, 16 April 1993.

HAGAN, Kenneth J., Professor, "The Current State of Naval History in the United States," Yale University/Naval War College Conference, New Haven, Connecticut, 17 June 1993.

HAGAN, Kenneth J., Professor, "Making of American Seapower," Swedish Armed Forces Staff and War College, Stockholm, Sweden, 2 February 1993.

HAGAN, Kenneth J., Professor, "The U.S. Navy's Response to the First Balkan War," Symposia: "Pavlos Melas-92" and "Moudros-92," Thessaloniki and Lemnos, Greece, 20-28 October 1992.

HAGAN, Kenneth J., Professor, "History of the U.S. Navy," History of the Armed Forces Symposium, Marine Corps Command and Staff College, Quantico, Virginia, 14 August 1992.

JOHNSON, David E., Professor, "Tailhook and the Culture of Militarism," Concerned Philosophers for Peace, Charlotte, North Carolina, 23 October 1992.

JOHNSON, David E., Professor, "Educational Responses to Tailhook," Society for Value Inquiry, Drew University, Madison, New Jersey, 2 April 1993.

JOHNSON, David E., Professor, "Prospects for Peace in the New World Order," Honolulu, Hawaii, 12 June 1993.

LOVE, Robert W. Jr., Associate Professor, "The

Guadalcanal Campaign," Chancellor's Military History Lecture, North Texas State University, Denton, Texas, 19 September 1992.

LOVE, Robert W. Jr., Associate Professor, "U.S. Naval Strategy and the Murmansk Run, 1941," Conference on the North Russia Convoys in World War II, Center for Military History and the RoskomArchiv, Moscow, Russia, 17-20 February 1993.

LOVE, Robert W. Jr., Associate Professor, "The Naval Action in the Gulf of Tonkin, 2-4 August 1964," Conference on Vietnam after Twenty Years, Center for the Study of the Vietnam Conflict, Texas Tech University, Lubbock, Texas, 22-24 April 1993.

LOVE, Robert W. Jr., Associate Professor, "From Neutrality to Belligerence: New Evidence on U.S. Naval Strategy and Policy, 1941," Society for the Study of World War II, Washington, DC, 28 May 1993.

MASTERSON, Daniel M., Associate Professor, "Sendero Luminoso and the Contemporary Crisis in Peru," Rutgers University forum on Contemporary Peru, New Brunswick, New Jersey, 8 November 1992.

MASTERSON, Daniel M., Associate Professor, "The Peruvian Armed Forces and U.S. Drug Policy in the Andean Region," United States Department of State Symposium on Inter-American Narcotics Policy, Washington, DC, 15 November 1992.

MASTERSON, Daniel M., Associate Professor, "The Armed Forces and the Contemporary Crisis in Peru," Cornell University Conference on the Contemporary Crisis in the Andean Region, Ithaca, New York, 14 March 1993.

PEELER, David P., Associate Professor, "The Gaze and Eroticism's Failure," American Culture Association Annual Meeting, New Orleans, Louisiana, 9 April 1993.

QUARTARARO, Anne T., Associate Professor, "Integration or Segregation: The Dilemma of the French Deaf Community and the Goals of Republican Education, 1880-1900," Western Society for French History, Orcas Island, Washington, October 1992.

SANDERS, J. Thomas, Assistant Professor, "The

Soviet Naval Archival Project," Conference on Russian and East European Archives, Yale University, New Haven, Connecticut, 6 January 1993.

SANDERS, J. Thomas, Assistant Professor, "The Social History of the Dissertation Dispute," Historisches Seminar Osteuropaeische Geschichte of the Johann Wolfgang Goethe Universitaet, Frankfurt, Germany, 18 July 1992.

SANDERS, J. Thomas, Assistant Professor, "Dissertation Defenses and the Public Profile of Academic History in Late Imperial Russia," Institute of History of the Russian Academy of Sciences, St. Petersburg, Russia, 16 June 1992.

SANDERS, J. Thomas, Assistant Professor, "The Political Profile of the History Professoriate in Russia at the end of the Nineteenth Century," Annual meeting of the American Association for the Advancement of Slavic Studies, Phoenix, Arizona, 20 November 1992.

SKALNIK, James V., Assistant Professor, "The Royal Professors of France in the Sixteenth Century: From Republic of Letters to Oligarchy of Letters," Western Society for French History Twentieth Annual Conference, Orcas Island, Washington, 21-24 October 1992.

SYMONDS, Craig, Professor, "Joseph E. Johnston and the Defense of Richmond," Annual Meeting of Blue and Gray Association, Richmond, Virginia, 22 July 1992.

SYMONDS, Craig, Professor, "Lee, Gettysburg, and Confederate Military Strategy," U.S. Marine Corps War College, Quantico, Virginia, 1-2 September 1992.

SYMONDS, Craig, Professor, "Jefferson Davis and Joe Johnston: A Case Study in Civil-Military Relations," U.S. Marine Corps War College, Quantico, Virginia, 2 September 1992.

SYMONDS, Craig, Professor, "Leadership and Moral Courage at Gettysburg," Annual Distinguished Lecture, Florida Community Colleges, Ft. Lauderdale, Florida, 18 November 1992.

SYMONDS, Craig, Professor, "The Atlanta Campaign," U.S. Marine Corps Command & Staff College, Quantico, Virginia, 20 November 1992.

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SYMONDS, Craig, Professor, "Johnston as Theater Commander, 1864," Civil War Round Table, Washington, DC, 10 February 1993.

SYMONDS, Craig, Professor, "Johnston's *Narrative* and Civil War Biography," Military Classics Seminar, Washington, DC, 16 February 1993.

SYMONDS, Craig, Professor, "The Civil War in the Western Theater," Annual Meeting of Civil War Round Tables, Wilmington, North Carolina, 15 May 1993.

TUCKER, Ernest S., Assistant Professor, "Nadir Shah and the Ja'fari *mazhab* Reconsidered," Annual Meeting of Society for Iranian Studies, Arlington, Virginia, 15 May 1993.

VANDEMARK, Brian, Assistant Professor, "The Lessons of Vietnam," White Burkett Miller Center of Public Affairs, University of Virginia, Charlottesville, Virginia, 17 November 1992.

Language Studies

Professor Gladys Rivera-La Scala
Chair

The Language Studies Department enjoyed a very strong year, with outstanding classroom and scholarly performance by faculty. Faculty members produced 12 articles on French, Spanish, Russian, and German philosophical, cultural, and literary topics and gave more than 20 presentations at national and international conferences.

In the field of language acquisition, the Annapolis Interactive Video Project continued to create interactive video lessons for intermediate French and Spanish, and established plans to develop lessons for Japanese, Chinese, and German. This project won large grants from the Department of Education and a new one from the National Security Agency.

The department has enjoyed strong enrollments in all languages and successfully expanded the Cox/Graubart overseas program and internship opportunities at U.S. embassies in France and Spain. We are proud of the large number of minors in all languages (97) among 1993 graduates who have elected to pursue language, literature, and area studies at advanced levels. These graduates will bring to the Navy and Marine Corps not only valuable linguistic skills but also in-depth knowledge of the regions where a specific language is spoken.

Sponsored Research

The Pragmatic Exploitation of the Impersonal [se]-Structure in Spanish Oral Discourse

Researcher: Associate Professor Penelope M. Bledsoe
Sponsor: Naval Academy Research Council (OMN)

The researcher is preparing a book in Spanish linguistics on structures associated with the Spanish impersonal pronoun [se]. The bibliography of syntactic and semantic studies of this structure is quite extensive; however, these studies have been inconclusive as to the variability of the form of the structure itself, factors which determine its form, and contexts of occurrence of the form. The researcher has found that the form of the structure is influenced by factors determining distribution of information in the Spanish clause, not strictly by a syntactic movement rule. The choice of one form of the structure over another depends on how the structure is to be used in context. In a pragmatic framework, the study explains the apparent anomalous occurrence of the impersonal-[se] structure in contexts where a definite referent would be expected. It was found that in certain social and cultural contexts it occurs to sustain sociolinguistic principles of communication where polite and formal language prevails. It occurs as an effort of the language user to shift responsibility and/or blame away from a logical subject.

Four chapters on the structure have been completed and the researcher traveled to Spain in the Summer of 1992 as part of a NARC grant to gather data by interview to complete her study of the pragmatic exploitation of the impersonal-[se] structure. An analysis of the data obtained by interview will be published separately as an article in the *Georgetown Journal of Languages and Linguistic* and will appear as chapter V, "The Occurrence of the Impersonal-[se] Structure in Spoken Discourse," in her book-length study on the [se]-structure in Spanish.

Women's Speech Patterns in Expressing Opinion:
A Case Study in Spain

Researcher: Associate Professor Penelope M. Bledsoe
Sponsor: Naval Academy Research Council (OMN)

This study is a part of an ongoing research project on women's speech in Spanish. It addresses the ways in which women express opinions on potentially sensitive topics, topics which in some way involve them directly, either personally, professionally or culturally. The directness vs. indirectness of their response and the linguistic structures employed to express their opinions is the primary focus of the research.

It is hypothesized that women's speech in general is much more direct in Spain than it has been reported to be in the United States, both in requesting and in expressing opinions. Studies of women's speech in the United States will be used as a source of comparison to gauge directness of response based on the occurrence of qualifiers, tag questions, hedges, and impersonal statements; therefore, the study is also cross-cultural.

The data for this research was gathered in Salamanca, Spain, during the Summer of 1992. The forum was a pre-arranged interview although the interviews often developed into informal conversations. Informants were middle-class, educated women with careers. They were told that the researcher was conducting linguistic research; however, the exact nature of the research was never revealed. The results of this research will be presented at the Mountain Interstate Foreign Language Conference at Clemson University in September 1993.

Pragmatic Exploitation of the Impersonal-[se] Construction
in Spanish

Researcher: Associate Professor Penelope M. Bledsoe
Sponsor: Naval Academy Research Council (OMN)

The researcher finds that the impersonal-[se] structure (a structure available to the language user in Spanish when the logical subject is unknown, generic, indefinite, or considered to be unimportant to the communication) occurs in seemingly anomalous contexts where the referent is definite and known to the speaker. The occurrence of an impersonal expression where a definite one might be expected is a reflection of politeness and formality conventions which require that in potentially embarassing situations, the speaker should avoid pinning down who is responsible for what action. This conversational strategy involv s to a great extent the pragmatic notion of conversational implicature which provides some explicit account of how it is possible to 'mean' in some general sense more than what is actually 'said.' An impersonal structure allows the speaker to refer to the subject indirectly and avoid personal reference. The intended meaning of the proposition is thus implied, not stated directly. In the context studied, the interlocutors are socially distant and there is a discrepancy in power status. The most frequent non-standard occurrence of the structure is in implied imperatives, where a direct imperative or command would be inappropriate. In other instances, impersonal statements and questions of opinion may be made in order to avoid seeming to impose the speaker's will or opinion, and thus deprive the other party of courteous options for counter interpretations, disagreement, or non-compliance. Finally, the non-standard occurrence of the impersonal structure is indicated when a speaker does not want to associate anyone in particular with the claim he or she is making, because of the controversiality of the claim and/or fear of reprisal. This article has been accepted for publication in *Hispania*.

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Chantal Chawaf: A Plea for New Ethical Values in Literature

Researcher: Assistant Professor Marianne Bosshard
Sponsor: Naval Academy Research Council (OMN)

The goal of this project is to rewrite and update a book-length critical analysis of the oeuvre of Chantal Chawaf, one of the better known contemporary French women novelists. To date, no comprehensive critical analysis is available on this author, either in French or in English.

Literature produced by French women writers conscious of their sexual identity has recently entered a new phase which can best be summarized, in Helene Cixous' words, as a "mission ethique," a new relationship between the ethical and the aesthetic aspects of "l'ecriture." Chantal Chawaf's most recent publications, as well as her lecture given in Spring of 1992 at the USNA and other U.S. campuses on her essay *Le Corps et le verbe: La Langue en sens inverse* (1992), clearly demonstrate this change. In this sense, her latest works reflect certain contemporary discourses in the field of sociology (Elisabeth Badinter); post-freudian psychoanalysis (Luce Irigaray; Janine Chasseguet-

Smirgel; Francoise Dolto), and contemporary "post-deconstructionist" philosophy (Michel Serres) which emphasizes the need for new ethical values governing the symbiotic relationship between mankind and nature.

Since the beginning of her literary career in 1974, Chawaf has always been known as an "ecrivain engage" and often was, mistakingly, labelled a "feminist writer." What is needed is a more accurate and up to date interpretation of the changes that occurred in her work during the past few years, a change that was not reflected in the previous research leading to the doctoral thesis by the researcher on Chawaf's oeuvre.

During the Academic Year 1993-1994, the researcher plans to further investigate secondary sources and to appropriately incorporate this current phase in literary production by Chawaf and other contemporary French women novelists into the researcher's analysis of the author's work.

Luis Palés Matos and his Black Poetry

Researcher: Assistant Professor María E. Castro de Moux
Sponsor: Naval Academy Research Council (OMN)

Luis Palés Matos is considered to be one of the best Puerto Rican poets. Particularly his Afro-Antillean poems have received well-deserved attention from literary critics. However, there is no study that relates his choice of literary topics and the development of his style within the framework of his socio-economic background and the particular circumstances of his life. Given the reality of the segregated social life of the Puerto Rican elite from less affluent social classes during the 1930's, a fact reflected in literary conventions of the period, current criticism has not explained why a writer from a middle-class, white family would choose to devote a good portion of his poetry to explore Black culture in Puerto Rico and the Caribbean.

Through a biographical and historical approach, Palés' early poems were examined, showing a progressive change from a detachment of socio-political events and a focus on European

tastes, esoterism and lyrical poetry, to a growing interest in Puerto Rican problems and culture, first through poetry devoted to the country folklore and gradually to an understanding of the relationship between race, culture, and national identity. By finding in Afro-Antillean culture a ground for all Caribbean emerging nations, he correctly identified Puerto Rican culture as Afro-Hispanic. During the first half of the 20th century such views were unthinkable by the Puerto Rican upper-classes and intellectual elite which considered of cultural value only the art and literature coming from Europe. Six chapters were completed and revised. Reader Professor Juan Manuel García Passalacqua, a specialist in Caribbean politics and culture, has suggested a preliminary chapter to introduce the study. Recent bibliographical references are presently being added and an introductory chapter is being written.

LANGUAGE STUDIES

Rethinking Realism in Our Time

Researcher: Associate Professor Eva L. Corredor
Sponsor: Naval Academy Research Council (OMN)

The purpose of this ongoing study, which received partial NARC funding during the Summer of 1992, is to redefine the concept of realism in the light of twentieth-century theories. In examining views such as the aesthetic theories of Theodor Adorno, the definitions of "postmodernism" by Fredric Jameson, the pragmatist approaches of Richard Rorty, the avant-garde analyses of Peter Burger, and the "humanistic realism" of Hilary Putnam, an attempt is made to update the concept of realism in a way that would avoid the dogmatism of Gyorgy Lukacs and the nihilism of more recent linguistic philosophers. Some of the results of this study have been presented at conferences at the University of Massachusetts, Amherst, and the Rensselaer Institute of Technology in Troy, New York. The study will be included as a chapter in a publication on the French Novel celebrating the centenary of Emile Zola's *Les Rougon-Macquart*, 1893-1993.

Aspects of Basque

Researcher: Instructor Ana I. Echavarri-Dailey
Sponsor: Naval Academy Research Council (OMN)

In Linguistics, the theoretical framework which has come to be known as the principles and parameters approach which was introduced by Chomsky in *Lectures on Government and Binding* (1981) concentrates on the general principles, constraints, and parameters that might indicate how language acquisition takes place. The (G)overnment and (B)inding model (G.B.) is based on the belief that language is a cognitive system, which is in large part innate and, as such, part of our biological endowment. This concept of language motivates the quest for the principles on universal grammar (U.G.) that form part of our ability to create language.

The topics of the Ph.D. dissertation "Aspects of Basque Syntax" are studies of grammatical constructions in Basque which exhibit peculiar behavior, uncommon to other languages, and therefore difficult to explain within the G.B. model. One of those aspects is "Focus in Basque." The relevance of focus in the structure of the Basque language was first noted by Severo Altube. In his book, *Erderismos*, he noted that in Basque, the focused element of a sentence must be placed immediately before the verb. Current linguistic research, building on this study, has concentrated solely on postulating a preverbal syntactic position to where the focused element must move in Basque. This approach ignores other focusing strategies, and so far has not been able to explain the problem of focus in negative sentences.

In the past, the researcher observed that in addition to the main focusing strategy mentioned by Altube and others, there are other strategies, similar to the ones used in Spanish or English that are also common to Basque: right dislocation, left dislocation, and in some cases, postverbal placement of the focused element. The researcher concentrated on the type of focused elements that can be placed postverbally.

During the study period ending in September 1992, the researcher provided an explanation for focus in Basque negative sentences, a persistent problem for any analysis that proposes a unique syntactic preverbal focus position. In Basque negative sentences, the focused element is placed postverbally, but before the inflected auxiliary. The researcher believes that there exists a second position in Basque, reserved for contrastive purposes, and that it is to that position that focused elements in negative sentences must move because of their contrastive nature.

For the study period ending in September 1993, the researcher has outlined a functional explanation for constituent predicate focusing, in particular predicate focusing with the particle EGIN. In the Basque linguistic literature there have confusing accounts of the use of the particle EGIN for verb

focalization. Through the study of novels and plays, the researcher has elucidated the use of this particle in two dialects, and proposes a functional explanation for its use. "Focus in Basque" will be included in the Ph.D. dissertation "Aspects of Basque."

Annapolis Interactive Video Project

Researchers: Associate Professor William H. Fletcher, Project Director, Assistant Professor Marianne Bosshard, Assistant Professor Christopher D. Buck, Assistant Professor María E. Castro de Moux, Associate Professor Eva L. Corredor, Associate Professor Audrey Gaquin, Associate Professor Elsa M. Gilmore, Professor John A. Hutchins, Visiting Instructor Lieutenant Commander Irmli Kuehnel, Associate Professor Ludmila A. Pruner, Professor Gladys M. Rivera-La Scala, Instructor Yumei Sun, Professor Sharon Dahlgren Voros, and Professor John D. Yarbro
Sponsor: National Security Agency

Since its inception in 1985, this project has expanded into a team of professors who compile videodiscs and author interactive video (IAV) lessons for Spanish, French, Russian, German, and Chinese. Project members have developed delivery and authoring software for a standard approach to creating lessons and have produced extensive documentation to guide authors through the process: authors combine selections from a set of some twenty presentation and exercise template types into a lesson structure and provide lesson content in text, graphic and "control" (script) files produced with USNA-developed authoring tools and commercial graphic software. The project team regularly shares its software and its IAV expertise with other Naval Academy departments, government agencies, and educational institutions.

Currently over 700 midshipmen are benefitting from some 140 IAV lessons in four languages. Thanks to fourteen lessons authored by Lieutenant Commander Kuehnel, students in elementary and intermediate German have joined that group, and IAV has assumed a more prominent role in the intermediate French curriculum. A new 50-station multimedia facility in Nimitz Library will afford midshipmen access to IAV whenever the library is open, greatly increasing the potential number of student learning sessions per week.

This year team members have compiled five new videodiscs in Spanish, French, and Chinese. Agreements with the copyright holders permits distribution of the videodiscs and lessons developed by team members beyond U.S. government agencies. The basic lesson delivery and authoring software has been reprogrammed in C++ to support many improvements in lesson design, to permit widespread distribution of project software, and to enable delivery on a wider range of hardware configurations.

The Annapolis Interactive Video Project continues to expand the scope of its internationally recognized pioneering work. Under a grant from FIPSE (Department of Education), the project is collaborating with Southwest Texas State University to complete development of IAV authoring templates which run on both Macintosh and IBM-compatible hardware. In the summer of 1933, USNA hosted one of three week-long authoring workshops organized under this grant, bringing language instructors from throughout the country to Annapolis.

Interactive Video Lessons for Intermediate French

Researchers: Associate Professors Audrey Gaquin and Elsa M. Gilmore
Sponsor: Naval Academy Instructional Development Advisory Committee

Interactive video lessons have been available in Advanced French, FF301-302, since 1986, and the large-scale Annapolis Interactive Video Project has developed weekly lessons for beginning and intermediate Spanish. Some interactive video programming for Russian is also in use.

Interactive video allows students to view video segments individually, in the language laboratory, as

assignments. After viewing the segments, students complete on-screen computerized lessons based on them, designed to reinforce the students' listening comprehension skills and unterstanding of the target culture. With the technology developed by the Annapolis Interactive Video Project, students' comprehension is tested as part of the completion of each assignment, and the results are tabulated for their instructors. Interactive video frees class time for conversation practice, grammar explanation and practice, reading, and composition work. Most importantly, each student has the opportunity to work at his/her own pace on the most challenging of the four language skills, listening comprehension.

During the Summer of 1993, Professor Gaquin completed six additional lessons for the FF201-202 interactive video program, including the training lesson "Le Sel" and five full-length lessons: "L'Armée et les jeunes," "Le Patin à roulettes à Paris," "Travail de nuit pour les femmes," "Le Bac professionnel," and "Generation malaise." New text types included a silent identification of different commando exercises, a matching of speaker and statement, and literary and historical cultural capsules.

In addition to providing intensive practice in listening comprehension, and freeing class time for the other activities mentioned above, the use of television segments, which provide appealing visual cues, motivates the midshipmen to make serious efforts to understand the accompanying speech, and provides clues to its content. As the closest substitute to direct contact with French people and their culture, the segments, involving political, social, economic, and cultural current events, bring contemporary France into the classroom and sharpen students' powers of observation and analysis. The accompanying lessons include lexical and cultural explanations, and both test and reinforce the information presented in the segments.

Students were asked to include on their end-of-semester course evaluations comments on their reactions to the interactive video lessons and their assessment of the effectiveness of the program. Investigators involved in earlier interactive video projects have been asked to inspect and evaluate the intermediate French project during the summer of 1992. The development of a video-mediated computer adaptive test to evaluate students' proficiency is not within the scope of the present project.

Interactive Video Lessons for Intermediate French

Researchers: Associate Professors Elsa M. Gilmore and Audrey Gaquin
Sponsor: Naval Academy Instructional Development Advisory Committee

Under the original grant, the writer co-produced (with Professor Audrey Gaquin) a videodisc of authentic video materials. The segments were selected from recent France TV-Magazine broadcast tapes with a view to complementing the cultural and linguistic content characteristic of a college-level intermediate French course. During the first year of the project, three interactive computer lessons stressing the development of listening comprehension skills were written to accompany the segments. They were: "Le TGV," "Gastronomie de Demain," and "Mangez du Pain!" Each of these lessons includes an innovative exercise. "Mangez du Pain!" and "Gastronomie de Demain" were given optional "cultural screens." These provide the student with social and linguistic information that should enrich understanding of the

lesson. In its original form, "Le TGV" included a module integrating the video lesson's context with related vocabulary previously presented in the FF202 classroom. Due to an end-of-academic-year decision to change the FF202 textbook, the lessons planned for completion at the last writing of this form had to be abandoned. Instead, to complement the FF202 syllabus, this writer has written the following lessons: "Francoscopie," "L'Affaire du Tchador," and "La Ceinture Automatique." "Le TGV" was also significantly changed to more closely match the vocabulary presented in the new FF202 textbook. This involved rewriting approximately one fourth of the lesson. All of the new lessons continue the practice of "contextualization" by the use of "cultural screens."

White Western Philosophy and Psychology in Black American Fiction: A Re-reading of Toni Morrison's Sula

Researcher:Assistant Professor Monika Hoffarth-Zelloe
Sponsor: Naval Academy Research Council (OMN)

The researcher started this project during the previous year funded by NARC stipend and finished her investigation during the past summer. The researcher analyzed the hidden Western philosophical and psychological elements in Toni Morrison's fiction, a topic particularly relevant in the current debate among Afro-American scholars regarding Henry Louis Gates' book *The Signifying Monkey: A Theory of Afro-American Literary Criticism*. In this study, Gates applies the Western post-structuralist inquiries of Paul de Man, Jacques Derrida, and Geoffrey Hartman to Afro-American fiction, suggesting new directions for critics and teachers of Afro-American literature to pursue.

The scholarly debate about using Western approaches to gain a better understanding of Afro-American texts as well as a personal meeting with Henry Louis Gates has inspired the researcher (a) to inquire in how far Morrison's texts resemble Western texts; (b) to examine in how far she employs philosophical ideas and psychological theories that comprise the Western tradition, and (c) to interpret her novels from a White Western female perspective.

Text Comprehension and Foreign Language Reading: Theory and Practice

Researcher: Assistant Professor Elizabeth M. Knutson
Sponsor: Naval Academy Research Council (OMN)

Theory and models of reading and text comprehension are of interest to researchers in a number of disciplines, including text linguistics, literary pragmatics, cognitive psychology, and first and second language acquisition. This research study will demonstrate this convergence of theoretical concerns and argue that text comprehension theory can inform and connect all levels of foreign language learning and instruction.

Research in the fields of cognitive psychology and information processing have yielded interactive models of reading comprehension which stress the contribution of both text-based and reader-based factors to relative difficulty or readability of any given text. Text-based factors include elements of text structure such as lexicon, syntax, grammar, and discourse or rhetorical organization. Reader-based factors include background knowledge relating to cultural content, text topic, and generic conventions.

Because of the interaction of both kinds of variables, a reader's proficiency is not absolute, but rather varies with the text. Recent research in foreign language learning has focused in particular on the importance of the reader's contribution to meaning and on the reader's cognitive processes. In this study, theory and research relating to foreign language reading comprehension are reviewed, and aspects of text comprehension dealing with both text structure and reader literacy are analyzed; in addition, the study suggests implications of current theory for instructional practice dealing with both literary and cultural/expository foreign language texts.

The research comprises a two-part study (in article form), the first part dealing with the text-centered issues of text difficulty and readability, and the second dealing with the reader-based concepts of cultural/literary competence and intertextuality.

Second Language Acquisition of English Reflexives by Japanese Speakers and Japanese Reflexive "Jibun" by English Speakers

Researcher: Instructor Chiyo Myojin
Sponsor: Naval Academy Research Council (OMN)

The researcher investigates how native speakers of Japanese learning English acquire English reflexives and also how native speakers of English learning Japanese acquire the Japanese reflexive JIBUN by extending Manzini and Wexler's (1987) parameter setting model for first language (L1) acquisition to second language (L2) acquisition.

The researcher, therefore, examines how Japanese learners of English and English learners of Japanese set values of the governing category parameters. The investigation continues to determine whether learners observe the Subset Principle (Berwick 1985) and succeed in acquiring the correct L2 value, or whether they unsuccessfully transfer their L1 value to the L2 grammar, or adopt a value which is that of neither the L1 nor the L2. Even though the Subset Principle is not applicable to L2 acquisition, it seems that Universal Grammar (U.G.; Chomsky 1981, 1986, 1989) is still applicable. Thus, this finding would support Manzini and Wexler's (1987) hypothesis that although learning principle and UG are in different modules, they are interacting with each other.

Juan de Mena's Coplas de los siete pecados mortales: Second and Third Continuations: A Critical Edition and Study

Researcher: Professor Gladys M. Rivera-La Scala
Sponsor: Naval Academy Research Council (OMN)

This book includes the first critical edition of the Second and Third Continuations of the *Coplas de los siete pecados mortales*, left unfinished at Juan de Mena's death, and an intertextual analysis of the main poem and its three continuations. The first chapter contains a comparative study of the four works based on themes, imagery, meter, and rhyme. In the second chapter the author gives detailed, firsthand descriptions of the manuscripts and 16th-century printings used in establishing the base text and discusses the interrelationships that exist between the many versions of the works. A corrected version of the continuations in modern script follows. Editorial, literary, and linguistic notes comprise the text section which ends with a glossary of medieval Spanish terms and one of proper names. Included in this volume is an extensive bibliography of primary and secondary source materials on Spanish and European 15th-century didactic poetry. The researcher has a publication contract with Studia Humanistica for this book which she must honor.

Adjuvancy and Opposition: A Study of Supporting Roles in Pedro Calderon de la Barca (1600-1681)

Researcher: Professor Sharon Dahlgren Voros
Sponsor: Naval Academy Research Council (OMN)

This book-length study combines the methodology of semiotics with archival research on Pedro Calderon's secular and religious drama. While supporting or secondary roles are often overlooked in drama studies, they provide keys for interpreting the playtext, since they complement and comment on the action of the main characters. Adjuvancy and opposition, terms from A.J. Greimas' semiotic

model, imply actantial functions of characters of subordinate social rank, and hence often marginalized figures. The researcher made a presentation on feminine *ingenio* or wit as seen in Calderonian drama, based on archival research this summer into literature read by women in the seventeenth century, the *exempla* books, such as Boccaccio's *De claris mulieribus* and lives of saints, since they give models for feminine behavior. Treatises are not consistent as regards feminine wit or ingenuity. While 16th-century authors view women as essentially biologically determined by the humors, 17th-century theoreticians begin to question

Aristotelian notions of gender. The researcher has located several plays, many without modern editions, such as Antonio Mira de Amescua's *Amor, ingenio y mujer* [Love, Wit, and Women], that question gender bias against feminine intelligence and depict women as rational and capable of governing. Also explored were edicts on women's dress codes, such as the forbidding of veils to be worn in the streets, first an edict against Muslim women and then against all women. Such information brings historical data on clothing that influenced staging and acting, as well as revealing details on social and gender-coded behavior.

The Feminine Adjuvant

Researcher: Professor Sharon Dahlgren Voros
Sponsor: Naval Academy Research Council (OMN)

This theoretical approach to the Spanish Golden Age Drama extends the semiotic model of adjuvancy from A.J. Greimas in connection with Thomas Pavel's concept of plot dynamics to analyze feminine supporting roles in Calderon. Feminine adjuvants or helpers as actants have been considered secondary in importance to male roles, to such an extent that scholars such as Leo Spitzer have undervalued their contribution to dramatic action. With semiotics as a methodological approach, the researcher challenges the notion of feminine insignificance or triviality to show that Calderon clearly values his feminine creations. The research distinguishes between "mediated adjuvance"

and "unmediated adjuvance," a concept from Claude Levi-Strauss, to trace women as using objects, magic (mediated) versus women using their own wit (unmediated) as a means of assisting in male-centered exploits. One thematic or semiotic model is insufficient to track the range of action in Calderon's handling of feminine adjuvancy. Thus, the combination of models permits a more diverse analysis of feminine stage presence.

This research project has been accepted for publication in *The Golden Age Comedia: Text, Theory, and Practice*, Purdue University Press (February 1994).

Independent Research

Subject Inversion in Spanish and Narrative Style: A Case Study of <u>Los de abajo</u>

Researcher: Associate Professor Penelope M. Bledsoe

The proposed functional value of subject inversion in Spanish is that of focusing the subject NP. This non-contrastive and non-emphatic subject focus is achieved by placing the subject NP in clause-final position, where it is appropriately highlighted by normal sentence stress. The typical clause

configuration resulting from this inversion is: (temporal or spatial adverb) + verb + subject NP + (postmodification). In a discourse, the function of this construction, sometimes referred to as "existential" or "presentational," has been identified identified by Hatcher, 1954; Contreras, 1978; and

Suner, 1984, as asserting the existence of subject. The researcher addresses the function of the focused subject NP and the existential or presentational clause of which it forms a part in a narrative. By examining its occurrence in *Los de abajo*, it is shown that this construction with a postposed subject brings subject NPs, both animate and inanimate, into focus as simply being or existing. The verbal and adverbial phrases simply serve as devices for getting the subject NP onto the scene and situating it in time and space. Passages from the novel are used to illustrate this function. In particular, it is shown how Azuela exploits this structure in a narrative replete with action and violence to slow down the action and give the reader a respite in a world he paints as otherwise peaceful and beautiful with splendid descriptions of vistas and sounds. The author "paints" scenery with the construction exactly as Hatcher describes in her seminal study of the existential sentence.

The results of this research were presented at the Northeast Regional Conference of the American Association of Teachers of Spanish and Portuguese at St. Anselm College, New Bedford, New Hampshire, September 1992. In response to the interest expressed in the research as it pertains to teaching reading strategies, the researcher plans to make some revisions and submit the research for publication in *Hispania*.

The Function of V-S Word Order in Spanish

Researcher: Associate Professor Penelope M. Bledsoe

The objective of this research is to show that a communication-based theory which is based on the notions of salience, highlighting, and context of occurrence, can explain and account for subject NP postposition in Spanish. It is argued that postposition is a kind of marking device; it marks the subject NP as communicatively salient. A subject-focus structure is created by virtue of the occurrence of the NP in neutral stress and focus position in the Spanish sentence. Subject NPs are more salient in this position not simply because they are out of default pre-position, but because they are in the position of sentence stress and focus.

The researcher examines and describes the properties of such a structure at the lexical, sentence, and discourse levels. At these levels, the following questions are addressed. At the lexical level, are there specific classes of noun phrases and/or verbs which may enter into the verb-subject (V-S) structures? At the sentence level, what role does stress and/or word order play in the assignment of focus in Spanish? And at the discourse level, in what contexts is a clause with a postposed focused subject NP appropriate and what if any restrictions or constraints apply to its occurrence in a context? And finally, what is the nature of these constraints?

The findings of this research were presented at the 1992 Annual Meeting of the American Association of Teachers of Spanish and Portuguese in Cancun, Mexico. They are currently being revised and will be presented for publication in the Fall of 1993. ERIC/CLL of Arlington, Virginia, has contacted the researcher requesting a copy of this paper for their permanent database and permission to announce the research in their monthly abstract journal *Resources in Education*.

The Mythological Theme of the Woman as a Path to the Spirituality of the Flesh

Researcher: Assistant Professor Marianne Bosshard

The goal of this project is to analyze, from various points of views, the "mythème de la femme comme initiatrice a la spiritualité de la chair" which constitutes the center of Chantal Chawaf's oeuvre.

Marked by violence since the day of her birth (her mother being killed on the way to the hospital by a bomb attack on Paris in 1943), every single text published by this author attempts to incorporate

into the symbolic domain of language the psychological and physical experiences of individual human beings. How to "revive" our language made up of abstraction is one of the key questions that motivate this author's texts. According to Chawaf, it is up to the contemporary writer and poet to "spiritualize our experiences as creatures of blood and flesh" and to arrive at a "verbal, integral translation" of this often neglected aspect of our human existence. In her writings, she often refers to the "myth of Eve," and the "myth of the courtesan" in the Sumerian *Epic of Gilgamesh*, both myths about two female figures that played a maternal as well as a spiritual role in the early stages of human civilization. According to the author, it is necessary to go back to these mythological origins in order to complement the self-destructive tendencies inherent in the "law of the father" and/or the "law of the son" that have dominated Western Civilization.

The researcher plans to analyze this mythological theme in order to establish its particular paradigmatic significance in Chantal Chawaf's works. The result of this study will be presented at the International Conference on "Mythes dans la litterature contemporaine d'expression francaise," to be held at the University of Ottawa, Canada, in March 1994.

Chantal Chawaf: Excerpts from L'Intérieur des heures: The Maternal Magma

Researcher: Assistant Professor Marianne Bosshard

This project is part of an anthology of selected texts by francophone women writers throughout the centuries, entitled *Lire des femmes en francais: Contribution à une lecture*. The anthology will serve as a textbook for graduate students in French literature.

In this article, the researcher analyzes the development of two major aspects in Chantal Chawaf's oeuvre: namely the relationship between mother and daughter, and the relationship between female and male characters. Following the author's "regressive discourse" which traces its way back to the "pre-verbal" states of being, the researcher sheds new light on the complexity of the "maternal imago" that leads to an identity crisis in many of Chawaf's protagonists. The uneasiness with which her male and female characters face the feminine and the maternal reflects current debates in the fields of sociology and post-freudian psychoanalysis. In her analysis, the researcher proposes some guidelines as to the interpretation of the apparent impasses created by a writing that is both "regressive" and "redemptive" in its attempt to represent human beings in their psychological, physiological, and spiritual integrity.

The Writings of Françoise Chandernagor

Researcher: Assistant Professor Marianne Bosshard

This article offers a critical analysis of the oeuvre of Françoise Chandernagor whose publication of *L'Allée du Roi* in 1981 earned the author two distinguished literary prizes. This text, which was immediately translated into several languages, is a fictional autobiography of Françoise d'Aubigné, Marquise de Maintenon, better known as the "secret wife" of Louis XIV. In her subsequent works, a voluminous trilogy entitled *Lecons de tenebres*, the author paints a satirical portrait of the political, intellectual, and artistic milieux during the presidency of Valéry Giscard d'Estaing. In her analysis, the researcher pays particular attention to the treatment of female characters and their development throughout the author's work.

This article will be included in the *Dictionnaire litteraire des femmes de langue francaise* to be published later on this year by the Edition des femmes, Paris.

The Writings of Annie Cohen

Researcher: Assistant Professor Marianne Bosshard

This essay offers a critical appreciation of the oeuvre of a less well known contemporary French woman writer who, since 1980, has published five novels, several texts of poetry and drawings (known as "rouleaux d'ecritures"), as well as numerous articles in a variety of literary journals. With the publication of *Histoire d'un portrait* (1992), the author gained a certain notoriety for having "painted" in words a portrait of President Francois Mitterrand whom she met a few years earlier at an exhibition of her drawings and sketches. The researcher analyzes the literary development of this author who, like Helene Cixous, was born and raised in Algeria, and who participated in the MLF movement in France in the late 1960's. The researcher pays particular attention to the "geographic" stylistic and semantic features that reflect the author's profession as a Professor of Human Geography.

This article will be included in the *Dictionnaire litteraire des femmes de langue francaise*, to be published later on this year by the Edition des femmes, Paris.

Some Reflections on the Post/Post-structuralist Moment, the Writing in the Feminine and Chantal Chawaf's Ethics

Researcher: Assistant Professor Marianne Bosshard

This article examines the "writing in the feminine," and in particular the poetics of Chantal Chawaf, in the light of "post/post-structuralist feminist criticism" concerned with "the politics of recuperation and negotiation." The article is a response to a recently published text by the feminist critic, Laurence Enjolras (*Femmes ecrites: Bilan de deux decennies*, Stanford French and Italian Studies, 1990), in which the author arrived at the conclusion that the movement of "writing in the feminine" has come to an end due to the lack of transcending paternalistic values that, historically speaking, always have defined the concept of "femininity." By taking into account more recent works by the writers referred to in Enjolras' study, as well as recent debates on this issue, the researcher demonstrates that the "ecriture du/au feminin," rather than being a "closed chapter," has entered a new phase, searching for values that re-connect aesthetics with ethics.

This article will be included in Vol. IV of *Continental, Latin-American and Francophone Women Writers*, to be published later on this year by the University Press of America.

Types of Dramatic Discourse in the Entremés de los negros by Simón Aguado

Researcher: Assistant Professor María E. Castro de Moux

In this article, Juan Villegas' model of dramatic discourse is used to analyze the relation between speech and social status as revealed in Aguado's *Short Play on Blacks* (1602) revealing the conflict between slave owners, Black slaves and their legal rights. Although in the early 17th century, the human rights debate on Indians, a key issue in the court of Charles V, had simmered down, in Aguado's play Black characters will voice their right to just and humane treatment and to freedom based on arguments from 16th century displaced discourse. Underlying the text are two political ideologies in conflict: the dominant one of the defenders of the Empire, and the displaced liberal arguments of

priests and missionaries who defended the right to freedom of Indians and Blacks and their right to just treatment. In the skit, the slaves use Catholic theological, philosophical, and legal arguments to further their rights and to subvert an unjust social order. However, since the solution to this problem lies ahead in history, the enslaved characters end up by accepting the rule of their masters and by adopting their owners' dramatic discourse. Thus, the discourse of the slaves is silenced at the end. The play's value for modern times lies in its being a social document of Baroque Spain and in the surprisingly modern dramatic discourse of marginal groups defending their rights to freedom in Imperial Spain.

This article will be published later on this year in the *Bulletin of the Comediantes*.

Dramatic Discourse in the Entremés del Platillo: Short Play of the Spanish Golden Age by Simon Aguado

Researcher: Assistant Professor María E. Castro de Moux

Pícaros (knaves) and Indianos (colonists returning from the New World) were marginal groups in Spain during the 16th and the 17th centuries. Both groups became literary types in the novel and theater of the period. In Aguado's short play two knaves, Novato and Pobreto, make fun and trick a recently arrived "Indiano." Mockery is based on the commonly held stereotype of the "Indiano" as an uncouth, naive, and rich social climber. In order to determine the various types of dramatic discourse contrasted in the play, the article examines Aguado's text through Juan Villegas' model as presented in his book entitled *Ideología y discurso crítico sobre et teatro de Espana y América Latina*.

The *Entremés del Platillo* text explores the ideology of hegemonic and marginal groups. Money is the fundamental element of conflict between "Pícaros" and "Indianos." Although both groups are marginal, their discourse reflects the values held by dominant groups in society. All of the play's characters accept society's division by birth, class, and money differences. Social status is determined by birth and cannot be altered. Other important social tensions in the play include conflicts between Old Christians and New Christians of Jewish descent, as well as Spaniards from Spain and Spaniards returning from the Indies. Because both knaves identify with the "status quo" and the "Indiano" wants to belong and mimics what he thinks are urbane manners, the play does not have subversive values as all characters function within predominant political and social structures of the period.

This article will be published as part of the Golden Age Theater 1992 Symposium Proceedings.

Confrontations with György Lukács

Researcher: Associate Professor Eva L. Corredor

This project, which in its initial stages received partial funding from NARC, has been ongoing for a few years. It consists of a collection of essays on the theories of Gyorgy Lukacs viewed in confrontation with contemporary critical theory and philosophy. Each chapter deals with one major aspect of Lukacs's theories, e.g. the genre of the epic in relation to the form of the novel, modernism, expressionism, historicism, the role of the intellectual, or a comparison of Lukacs's theories to those of other important theoreticians such as Michael Bakhtin, Michel Foucault, Lucien Goldmann and Jacques Leenhardt. The results will be published in book form.

Lukács after Glasnost

Researcher: Associate Professor Eva L. Corredor

This project was inspired in 1989 by the recent ideological and political revolutions in Russia and Eastern Europe. It is based on a series of recorded interviews with about ten scholars, both in the U.S. and in various countries of Europe, who at the onset of their careers had been influenced by the theories of the Hungarian philosopher and literary critic Gyorgy Lukács and since then have established themselves in their own right as major philosophers and theoreticians of the twentieth century. The results of this study will be published in book form.

Elements of Theoretical Linguistics in Priscian's Institutiones

Researcher: Associate Professor Audrey Gaquin

Twentieth-century linguistics, judging from a strictly modern point of view, dismisses Priscian's work as unscientific, lacking in method, and irrelevant to the progress of modern linguistics. Yet Priscian's place at the end of the long tradition of classical grammar, building on the work of his many predecessors and functioning as a principal source of information for medieval grammarians, points up his importance for the Western grammatical tradition.

An examination of Priscian's *Institutiones* shows that this work made available to Priscian's successors certain fundamental theories on the nature of language as well as doctrines about specific grammatical points. The presentation of the different levels of language and definitions of the noun and verb represent the most extensive theoretical discussions in Priscian's work. These discussions stress the importance of the semantic component in language production.

Priscian's discussions of specific subcategories of the parts of speech, such as the paradigm for the reflexive pronoun "sui," the formation of interrogatives, and the treatment of other types of "understood" elements in language, help to define the semantic component as a set of what may be called semantic wholes. These semantic wholes are matched with corresponding language forms, most of which, in turn, are generated by a smaller class of primary forms. The study of the semantic aspects of his theory promises to be useful not only for understanding classical linguistics, but also for evaluating Priscian's contribution to the medieval grammatical tradition.

This monograph is a re-working of the researcher's Ph.D. dissertation. It has been solicited for publication in the John Benjamins series on History of Linguistics. The researcher has completed the bibliographical update and the majority of the necessary revisions have been completed. The manuscript should be submitted for a preliminary review late in 1993.

A Different France

Researcher: Associate Professor Audrey Gaquin

A Different France is an anthology of documents from the seven non-immigrant minorities of France, whose languages and cultures are different from those of mainstream France: Basque Country, Brittany, Alsace, Corsica, Occitania, North Catalonia, and French Flanders. Recent laws passed by the French government to allow a measure of regional autonomy in France have had a significant impact on minority cultures in these regions, encouraging the revival of the minority languages, literatures, and art forms. Also, small but vocal autonomist and separatist groups in most of the minority regions have had an influence on policymakers in the French government.

A Different France makes available to students, teachers and scholars primary source materials

relating to the regional cultures of France. The anthology includes, for each of the seven regions, a historical introduction; an interview with minority leaders; articles on the political and economic issues concerning the region; sample lessons in the minority language; brief literary sections in the minority language (with translation into French), and information about customs, traditions and folk art of the minority. This anthology will be published later this year by University Press of America.

Structure and Ambiguity in Our Daily Secret Obscenities by Marco Antonio de la Parra

Researcher: Associate Professor Elsa M. Gilmore

This article explains the structure of de la Parra's best known play by focusing on its ambiguity. The researcher studies this characteristic in relation to the "atomistic" model put forth by Gilles Deleuze and Felix Guattari in their classical study *Anti-Oedipus*. As in Deleuze and Guattari's psychological model, *Our Daily Secret Obscenities* bases its structural coherence not on a single motivational complex or a single semantic level, but on many. The text's "unity" is derived from the complementary and/or contradictory interaction between these competing elements. The article focuses principally on the role of ambiguity in multiple characterization, in socio-political commentary, and in tragic-comic effect. This study will be included in the Fall 1994 issue of the *Latin American Theatre Review*.

New Cuisine: The Theatre of Marco Antonio de la Parra

Researcher: Associate Professor Elsa M. Gilmore

In this study of Marco Antonio de la Parra's controversial *The Raw, the Cooked, and the Rotten* (1983), the researcher analyzes the play's constant, if veiled, references to Chilean history. The "absurdist" dramatic text is interpreted as one which evokes Chile's evolution from social-democracy to military dictatorship and which anticipates the end of the Pinochet regime. In view of de la Parra's more recent works, the researcher also offers up *The Raw, the Cooked, and the Rotten* as the critical point of departure from which later plays step into a full-fledged postmodern esthetics.

This article will be included in a forthcoming English language de la Parra anthology edited by Dr. Charles Thomas, University of Wisconsin-Oshkosh.

Die Poggenpuhls: A Cabalistic Michaelmas Play in Jewish Vestment

Researcher: Associate Professor Sylvain Guarda

This essay argues that Fontane's penultimate novel, *Die Poggenpuhls* (1896), often characterized by many Fontane-scholars as "the mere ghost of a novel" because of its most questionable shape, should not be read as realistic entertainment or record of overheard conversations of the time but as a cabalistic thaumaturgy. This new reading not only does justice to the novelty of Fontane's unconventional narrative, but also brings to light the author's familiarity with the Jewish theosophie and its rituals.

<u>Der Stechlin</u>: A Spiritual Crusade into the Modern World

Researcher: Associate Professor Sylvain Guarda

This study offers a thorough analysis of Theodor Fontane's last novel, *Der Stechlin* (1898), a novel carefully haunted by mythic shades. Irony, parody, and humor, all three narrative modes are viewed as exclusive and necessary means for access to the manifestations of myth. Through the "Old Man of the Lake" sensing life in the shadow of death, Theodor Fontane points to an unalterable meaning lurking beneath the hollowness of modern life, a "magic" continuity, which is not only the expression of an ontological absolute but also an affirmation of both life and the arts.

The Language of Diplomatic Correspondence between Moscow and the Turkic Khanates: 1458-1600

Researcher: Instructor Dudley Hagen

The documents being examined for this doctoral dissertation at the University of California, Los Angeles, are a series of notes, drafts, and treaties. They were published in the middle of the last century. All of the documents are in Russian, but about half are translations from Tatar. The researcher is making a detailed analysis of the language of both types of documents, and bringing in linguistic facts from comparable documents preserved in the Tatar. The analysis is inteded to show that the Muscovite diplomatic language, which was still taking shape at this period, was under strong Tatar influence. Recent work by historians of Russia has suggested that Moscow's political institutions and statecraft were influenced in the same way.

Accent in Serbo-Croatian and Classical Greek: Some Parallels in Typology and Analysis

Researcher: Instructor Dudley Hagen

Parallels between work done on Serbo-Croat accent by Pavlelvic since the 1950's, and on Greek by Sydney Allen since the 1960's, are the main focus in this study. There is, of course, no direct link between the two languages, and their accent systems have obvious differences. But deeper similarities can be traced in the writings of these two analysts and others, working in fields usually separate. A striking illustration of those similarities is found in a close accentological parallel that Lesbian and Doric (the two opposite extremes of accentual innovation represented in ancient Greek dialects) show with the dialects described for two Serbo-Croatian speaking villages.

"Coniunctio Solis et Lunae": The Use of Alchemy as Narrative Symbolism in Toni Morrison's Fiction

Researcher: Assistant Professor Monika Hoffarth-Zelloe

This investigation revealed Morrison's choice of alchemist signs as narrative symbolism. Reading the *Collected Works* of C.G. Jung, and studying his explanation of alchemist symbols provided the researcher with the key to a genuine understanding of Morrison's ambiguous figurative language. This

article proves the usefulness of Jung's concepts and archetypal theories for African-American feminist scholars and critics and uncovers similarities between African-American texts and Western discourse, which enable non-black readers to give meaning to black-authored texts, and vice versa. The researcher analyzes how Morrison first deconstructs and then reconstructs Jung's concept of masculine and feminine duality in her fiction. By revealing the hidden alchemist symbolism in Morrison's novel

Sula, the researcher demonstrates in a comparative study (1) that the two main characters Sula and Nel initially embody the alchemistic opposites of "Luna" and "Sol," and (2) how the author gradually allows her characters a transformation countering the traditional symbolism of these alchemistic elements.

The question of whether a "coniunctio oppositorum" is achieved will be investigated at the end of the project.

The Roles of Stereotypes

Researcher: Assistant Professor Monika Hoffarth-Zelloe

This project will be included in the *Handbuch Englisch als Fremdsprache* to be published later on this year by Erich Schmidt Verlag, Berlin. It will serve as an informative source for students of English as a foreign language and English teachers. The different chapters will address the following areas: (a) English as a national language and as a world language; (b) English as a foreign language; (c) communicative strategies when learning English as a foreign language; (d) cultural content in the

teaching of English as a foreign language; (e) the reception of English literature; (f) the history of English and American studies at German universities, and (g) supplementary materials for students of English as a foreign language. The researcher's contribution will be part of the "reception of English literature," addressing basic literary theories with the focus on the function of stereotypes in literature.

Juan de Mena's <u>Laberinto de Fortuna</u>: A Critical Transcription and Concordance of ESP.MS 229 of the Bibliotheque Nationale, Paris

Researcher: Professor Gladys M. Rivera-La Scala

This work will be published by the Hispanic Seminary of Medieval Studies, University of Wisconsin-Madison, as part of their National Endowment for the Humanities-sponsored project, and the lexicon from the concordance will be included in the first *Dictionary of Old Spanish*, the first volumes of which are scheduled for

dissemination in the early 1990's. This thirty-year project, begun in the late 1950's by Professor Lloyd Kasten, has enjoyed yearly support from the National Endowment for the Humanities for over 10 years and the expertise and work of at least two generations of scholars from the national and international communities.

Ng Poon Chew and the Chinese in America

Researcher: Instructor Yumei Sun

This research project focuses on a Chinese American editor of one of the most influential Chinese daily newspapers published in San Francisco in the 1900's, Ng Poon Chew. The

Chinese daily that he edited, *Chung Sai Yat Po* [China West Daily], was one of the first Chinese dailies ever published in the United States and it lasted for more than 50 years. During that time, the

status of the Chinese in America had changed. The articles and editorials of the newspaper reflected the reactions among the Chinese immigrants to those changes. Most importantly, the newspaper voiced the concerns of the Chinese community; it constitutes one of the most important historical records of the time for the Chinese in America.

As one of the many ethnic newspapers published at the turn of the century, the survival and success of *Chung Sai Yat Po* also bears witness to the immigrant experience in America. The study of *Chung Sai Yat Po* will be of great importance to the immigration history of this country.

The primary materials are all in Chinese, which may explain why they have been left untapped over the years, even though research interest in Asian-American history soared drastically in the past few decades. Working with the newspaper gives the researcher a constant challenge because the written Chinese language used in the newspaper is archaic.

Publications

CASTRO DE MOUX, María E., Assistant Professor, "La *Política* de Aristóteles en *Fuenteovejuna*," *Noesis*, 8 (June 1992), 39-68.

This paper studies intertextual relations between a play (1619) by Spanish writer, Lope de Vega, and Aristotles' treatise on politics. Based on specific reference to Aristotles' *Politics*, this work in Lope's play is seen as the key for understanding Lope's political ideology which parallels Aristotelian thought displayed in the dramatic text. Lope de Vega's *Fuente Ovejuna* explores class differences in 15th century Castile which result in peasant revolts against feudal lords. In creating a collective hero, Lope anticipated the social theater of the 20th century. However, the hierarchical system survives in the play since, after killing the cruel lord, the peasants accept monarchical authority and power. The king restores harmony between the opposing groups through a restoration of the Law. Aristotles' *Politics* provides the ideological background for developing the complex dramatic discourse. In the end, moderate solutions to the peasants' revolution prevail as the result of just government decisions by the Spanish monarchs. The play does not end with the creation of a peasants' republic, unthinkable in the Imperial environment of Baroque Spain, but with the peasants' subordination to the monarch, as the constituted authority. Contrary to recent critical opinions, the play is not revolutionary since it lacks a revolutionary solution. It is rather an exploration on the causes of revolts and the means to avoid revolutions through moderation in government and in the application of justice.

CORREDOR, Eva L., Associate Professor, "Towards Teaching French Civilization in Context:

A Technology-Aided Approach," *Mid-Atlantic Journal of Foreign Language Pedagogy*, 1 (Spring 1993), 155-166.

This study demonstrates how technology, enhanced by the experience and supportive presence of the teacher, can be used toward the teaching of French civilization within a more authentic context. The focus of the article is on organizational and selection strategies and pre- and post-viewing or listening treatment of technological teaching aids.

CORREDOR, Eva L., Associate Professor, co-author, "MLA Statement of Professional Ethics," *Profession*, 92 (December 1992), 1-2; 75-7.

These are guidelines on professional ethics for the membership of the Modern Language Association which resulted from the debates of two consecutive committees that reviewed and compared such statements from documents of other learned societies and adapted them to the needs of the Modern Language Association of America. The statement was initiated by a motion made by the researcher at the Delegate Assemblee of 1986 at which she served as Regional Delegate for the Mid-Atlantic Region.

CORREDOR, Eva L., Associate Professor, "(Dis)embodiments of the Father in Maghrebian Fiction," *The French Review*, 66.2 (December 1992), 295-304.

This is a comparative study of postcolonial francophone fiction by Maghrebian writers from Algeria and Morocco. It discusses some of the socio-political and psychological problems shared by

these writers which found their synthesis in the literary expression of the relationship to the father.

CORREDOR, Eva L., Associate Professor, "Potential Conflicts Between Institutional and Personal Ethics," *Proceedings of the first Global Village Conference*, 7-10 February 1990, Barry University, Miami Shores, Florida, October 1992, pp. 125-130.

This article reflects upon situations within various professions that could lead to potential crisis between the ethics of an individual and those of the particular institution. It discusses realistic attitudes and choices and suggests ways to meet the challenge.

CORREDOR, Eva L., Associate Professor, "Report on Roundtable Discussion: Ethics in the Profession," *Proceedings of the first Global Village Conference*, 7-10 February 1990, Barry University, Miami Shores, Florida, October 1992, pp. 119-121.

This constitutes a summary of nine reports that examined ethical issues from various forms of organizational life such as business, educational institutions and government agencies within the context of the "global village." The debate focused on human resource practices such as hiring, termination, outplacement, competition, and sexual harassment and tried to find solutions to ethical problems and questions of social responsibility an individual may face in a professional environment.

GUARDA, Sylvain, Associate Professor, "*Unwiederbringlich*: Ein Fontanesches Weihnachts-oder Johannisspiel?", *Zeitschrift fur Deutsche Philologie*, III (Winter 1992), 558-576.

Through a careful analysis of the main characters Holk and Christine, this article throws light on Christine's puzzling suicide and comes to the conclusion that *Unwiederbringliche* is a Midsummer play (June 24 celebrated as the feast of the nativity of John the Baptist). Particular attention is paid to Holk's journey into the underworld.

HOFFARTH-ZELLOE, Monika, Assistant Professor, "Resolving the Paradox: An Interlinear Reading of Toni Morrison's *Sula*," *Journal of Narrative Technique*, 22,2 (Fall 1992), 114-27.

This article exposes the reader's difficulty of extrapolating a message from Morrison's novels.

The interpreter's reading process is rendered difficult due to the constant paradoxes which Morrison strategically employs. In her narrative *Sula*, Morrison seems to speak to us through Sula, an independent, free-thinking woman. Yet, what Sula says and what Morrison really means, become an enigma. Like many African-American authors, Morrison uses figurative language and paradoxes to say one thing and mean another. Reader perception versus reader manipulation comes into play. Which values does Morrison really support? Suggesting an interlinear reading approach, this article elaborates ways to resolve the paradoxes with which the reader is left.

KNUTSON, Elizabeth M., Assistant Professor, co-author, "Where is the Text? Discourse Competence and the Foreign Language Textbook," *Mid-Atlantic Journal of Foreign Language Pedagogy* 1 (Spring 1993), 167-176.

Increasingly, foreign language textbooks have espoused a pragmatic approach to the teaching of language, underscoring the value of communicative competence, functional language use, and conversational effectiveness, while at the same time retaining to some degree the more traditional goals of structural analysis and "knowledge about" language and culture(s). However, the notion of discourse competence, defined here as the ability to understand and produce connected, coherent speech in conversation, has remained relatively neglected by materials writers. The purpose of this study is to determine to what extent and in what manner grammatical and rhetorical discourse phenomena are addressed in current French textbooks which espouse communicative or proficiency approaches. In a survey of eight widely used elementary and intermediate French textbooks, the article analyzes the explicit claims and implicit assumptions about discourse which are reflected in grammar explanations, oral exercises, and samples of text. Trends such as chapter organization by speech acts, repertories of gambits and routines, and catalogues of useful expressions for conversation are an encouraging change from the strictly grammatical syllabus. Nevertheless, limitations remain. Initiatives to present language at the discourse level are characterized by the tendency to reduce discourse to lexical phrases, the failure to distinguish clearly between structures and expressions targeted for comprehension and those which students are expected to produce, and the absence of explanations of usage which are

informed by native speaker norms governing the use of verb tenses and other structures.

MYOJIN, Chiyo, Instructor, "The Necessity of Japanese People's Mental Change Toward More International Contribution," *Kochi Newspaper*, 4 March, 1993, p. 1.

This article describes the economic situation in the United States since the beginning of the Clinton administration. The writer admires the United States and the American people's attitudes toward their position as a world leader as demonstrated by sending troops to Somalia for humanitarian reasons. As for Japan's and the Japanese people's contribution to other countries, there has been more progress in the last few years than ever by passing the PKO bill. However, the article points to the importance of the need for the Japanese people to provide a more positive international contribution in order to share a world leadership role with the United States. Therefore, it is necessary for the majority of the Japanese people to realize their responsibility and role as a world leader as the Americans do.

PRUNER, Ludmila A., Associate Professor, "The New Wave in Kazakh Cinema, *Slavic Review*, 51,4 (Winter 1992), 791-802.

The term "New Wave" was first applied to works of new cinematographers of Kazakhstan and other Asian republics of the former Soviet Union during the 1989 International Film Festival in Moscow. Kazakh filmmakers disagreed with the Moscow interpretation of the New Wave as a surprise or unexpected phenomenon. The New Wave directors, Nugmanov and Kayev among them, regarded the

New Cinema as a result of a long-term project that started in the early 1980's. The article examines the history of the New Wave, its first film productions and artistic styles of its participants. Particular attention is devoted to different dynamics of the cinematic narrative. A comparative analysis between Socialist Realist art and New Wave creation is offered. The article offers a detailed review of six internationally recognized works of the so-called Alma-Ata group.

VOROS, Sharon Dahlgren, Professor, "Feminine Symbols of Empire in Thomas Kyd and Pedro Calderon: *The Spanish Tragedy* and *De un castigo, tres venganzas* [By one punishment thrice revenged]," *Pacific Coast Philology*, 27 (September 1992), 145-158.

Political ideology and its literary symbols have long concerned scholars of Spanish and English national dramas. This study examines feminine discourse and its symbolic value with a system of comparative semiotic models, based on the theories of Charles S. Peirce and Algridas Greimas. Even lyrical interludes in these plays are charged with ideological significance referring to notions of empire. Senecan revenge drama is common to both dramatists, concerned with corruption in the Court and the lack of communication between reigning aristocrats and their subjects. Women's roles are problematic, since they influence the course of action for vengence. The semiotic model makes clear that women are not marginalized from central political concerns, but through their performance signs, integrated into the main action of the play, they contribute to the understanding and interpretation of these political texts.

Presentations

BLEDSOE, Penelope M., Associate Professor, "The Function of V-S Work Order in Spanish," Annual Conference of the American Association of Teachers of Spanish and Portuguese, Cancun, Mexico, 14 August 1992.

BLEDSOE, Penelope M., Associate Professor, "Subject Inversion in Spanish and Narrative Style: A Case Study of *Los de Abajo*," Annual Northeast

Conference, American Association of Teachers of Spanish and Portuguese, St. Anselm College, New Bedford, New Hampshire, 24-26 September 1992.

BOSSHARD, Marianne, Assistant Professor, "Politique(s) et poetique(s) des fluides," Congres Mondial of the Conseil International d'Etudes Francophones, Strasbourg, France, 20-28 June 1992.

CASTRO DE MOUX, María E., Assistant Professor, "Los marginados en *La casa de los linajes*: Entremes de don Pedro Calderon de la Barca," Pennsylvania Foreign Language Conference, Duquesne University, Pittsburgh, Pennsylvania, 20 September 1992.

CASTRO DE MOUX, María E., Assistant Professor, "Esoterismo y Cabala en la poesía de Luis Pales Matos," Louisiana Conference on Foreign Languages and Literatures, Tulane University, New Orleans, Louisiana, 27 February 1993.

CASTRO DE MOUX, María E., Assistant Professor, "Canon de belleza, femenina y estereotipos raciales en un entremes de Quinones de Benavente," Thirteenth Annual International Golden Age Spanish Drama Symposium, University of Texas, El Paso, Texas, 18 March 1993.

CORREDOR, Eva L., Associate Professor, Chair, "Dimensions of Class," Conference on Marxism and the New World Order, University of Massachusetts at Amherst, Amherst, Massachusetts, 12-15 November 1992.

CORREDOR, Eva L., Associate Professor, "(Re)Visions of Realism," International Conference on Narrative, Rensselaer Polytechnic Institute, Troy, New York, 30 March-2 April 1993.

FLETCHER, William H., Associate Professor, "Language Learning and Technology: Opportunities, Challenges and Rewards," Conference on "New Technologies, New Teaching Techniques: Foreign Language Learning in the 1990's," Northwest Association of Language Laboratories, Willamette University, Salem, Oregon, 5-6 May 1993.

FLETCHER, William H., Associate Professor, "The Future of Multimedia in Foreign Language Learning," Conference on "New Technologies, New Teaching Techniques: Foreign Language Learning in the 1990's," Northwest Association of Language Laboratories, Willamette University, Salem, Oregon, 5-6 May 1993.

FLETCHER, William H., Associate Professor, "USNA-Developed Interactive Video Courseware and Imageware for Teaching French, German, and Spanish," Conference on "New Technologies, New Teaching Techniques: Foreign Language Learning in the 1990's," Northwest Association of Language

Laboratories, Willamette University, Salem, Oregon, 5-6 May 1993.

FLETCHER, William H., Associate Professor, "Choosing and Using Authentic Video in Foreign Language Instruction," Conference on "New Technologies, New Teaching Techniques: Foreign Language Learning in the 1990's," Northwest Association of Language Laboratories, Willamette University, Salem, Oregon, 5-6 May 1993.

FLETCHER, William H., Associate Professor, "Tapping in to Technology-Assisted Language Learning," Conference on "New Technologies, New Teaching Techniques: Foreign Language Learning in the 1990's," Northwest Association of Language Laboratories, Willamette University, Salem, Oregon, 5-6 May 1993.

FLETCHER, William H., Associate Professor, "US Naval Academy's Approach to Interactive Video Lesson Design and Production," Foreign Language Facilty, Education Services Office, Army Continuing Education, Ft Lewis, Washington, 4 May 1993.

FLETCHER, William H., Associate Professor, "Technology-Assisted Language Learning at U.S. Naval Academy: Current Initiatives, Plans for the Future," University of Washington, Seattle, Washington, 3 May 1993.

FLETCHER, William H., Associate Professor, "Tapping into Technology-Assisted Language Learning: A German-Teacher's Guide," American Association of Teachers of German Meeting, Cortland State University, New York, 24 April 1993.

FLETCHER, William H., Associate Professor, "Interactive Video with Authentic Materials in the Foreign Language Curriculum," Binghamton University, Binghamton, New York, 23 April 1993.

FLETCHER, William H., Associate Professor, "Where Are We Going and Where Do We Need to Go?", Discussant representing academic users in wrap-up session, Workshop on Advanced Technology for Language Learning, Army Research Institute, Alexandria, Virginia, 20-22 April 1993.

GAQUIN, Audrey, Associate Professor, "Problematique de la double appartenance culturelle dans le theatre occitan contemporain," Congres Mondial of the Conseil International d'Etudes Francophones, Strasbourg, France, 23 June 1992.

GILMORE, Elsa M., Associate Professor, "Lévi-Strauss in the Trash Heap: De la Parra's *The Raw, the Cooked, and the Rotten*," Mountain Interstate Foreign Language Conference, Virginia Tech University, Blacksburg, West Virginia, 8-11 October 1992.

GILMORE, Elsa M., Associate Professor, "*Matatangos*: pasion y muerte de Carlos Gardel," Louisiana Conference on Foreign Languages and Literatures, Tulane University, New Orleans, Louisiana, 25-27 February 1993.

KNUTSON, Elizabeth M., Assistant Professor, and Michael C. MacQueen, "Regional Identity and German Policy in Alsace (1940-1944)," American Association of Teachers of French Annual Convention, Strasbourg, France, 22 July 1992.

KNUTSON, Elizabeth M., Assistant Professor, "Reading Across the Foreign Language Curriculum," George Washington University Colloquium on Foreign Language Teaching and Learning: Literature in the Foreign Language Classroom, Washington, D.C., 2 April 1993.

KNUTSON, Elizabeth M., Assistant Professor, "Le Fantome de l'Opera: le charme de la supercherie," Binghamton University Fourth Annual Conference on Beyond the Limits of Realism: Metaliterature, the Uncanny, Simulacre, Binghamton, New York, 30 April 1993.

PRUNER, Ludmila A., Associate Professor, "Post-Communist Cinema: An Exploration," Conference on Post-Communist Cinema in Russia and CIS, Film and Video Studies Program of the College of Arts and Sciences, Oklahoma University, Norman, Oklahoma, 1-4 October 1992.

PRUNER, Ludmila A., Associate Professor, "The Cinematic Quotations in the New Wave Kazakh Cinema," 1993 Southern Conference of Slavic Studies, Atlanta, Georgia, 17-21 March 1993.

VOROS, Sharon Dahlgren, Professor, "*Amor, ingenio y mujer* in Calderon's *El escondido y la tapada*," Pennsylvania Foreign Language Conference, Duquesne University, Pittsburgh, Pennsylvania, 25-27 September 1992.

VOROS, Sharon Dahlgren, Professor, "Fashioning Feminine *Ingenio* [Wit] in Calderon's *Fuego de Dios en el guerer bien* and *Cual es mayor perfeccion*," Thirteenth Annual International Golden Age Spanish Drama Symposium, University of Texas at El Paso, El Paso, Texas, 17-20 March 1993.

VOROS, Sharon Dahlgren, Professor, "Antonio Mira de Amescua and Pedro Calderon and the Question of Feminine Wit," Northeast Modern Language Association, Philadelphia, Pennsylvania, 24-26 March 1993.

Political Science

Professor John A. Fitzgerald
Chair

O nce again, the Department of Political Science has been at the forefront of Naval Academy research and publications. In a field of study which demands currency coupled with sound methodology, the faculty and midshipmen of the department have excelled at bringing forth a vast array of fresh ideas and knowledge into the classroom. From domestic public policy to international relations, the impressive research accomplishments of the department helped to ensure that midshipmen would receive an education of the highest quality possible.

The breadth of political science research has once again been outstanding, with the list of research sponsors including such prestigious institutions as the National Endowment for the Humanities, the Hoover Institute, the Mobil Shipping and Transportation Company, the U.S. Congress Office of Technology Assessment, and the State Department. In addition, a number of Naval Academy political scientists were awarded publishing contracts with national publishing houses such as Dushkin, Macmillan, McGraw Hill, and Brown and Benchmark.

The culmination of the department's vigorous research effort was the publication of a number of books, chapters, articles, reviews, and papers. Moreover, this year's list of faculty presentations demonstrates an impressive variety of academic interchange spanning throughout the continents of Asia, Africa, Europe, and North America. This has been a showcase year for the department's talented faculty.

Equally important, midshipmen have continued to play a vital role in the department's research activity. In addition to the research associated with midshipmen participation in yet another successful Naval Academy Foreign Affairs Conference, a number of midshipmen participated in a variety of advanced independent research projects. Of special note, one of the department's Trident Scholars was able to present his paper at the Southwestern Political Science Association Convention in New Orleans during March 1992.

Sponsored Research

American Council on Education National Norms Study of College Students

Researchers: Professor Charles L. Cochran and Assistant
Professor Eloise F. Malone
Sponsor: Naval Academy Research Council (OMN)

This is an ongoing study of American college students' attitudes and behaviors which began in the late 1960's. The midshipmen began participating in the study in the early 1970's under the supervision of Professor Cochran. Since 1990, NARC grant funding was restored to reactivate the study which had lapsed while Professor Cochran served as department chairman. Each summer, the data sets have been recompiled as SPSSX system files and have been moved from the old mainframe computer to a SUN system in computer services. (Ultimately, it is the plan to move everything to the SUN system jointly owned by political science and economics.) The researchers wrote two articles in the spring of 1991 describing midshipmen attitudes and behaviors which were published in the Trident and reported on

in the *Capital*. In fall 1991, the Naval Academy once again began participating in the survey. Presently, the ACE study has become formally institutionalized at the Academy with reports given to the Dean of Admissions, Director of Institutional Research and Academic Dean and Provost. The survey will continue to be administered each fall, and it is now possible to look at trends over time. Some of the findings were used to support the midshipmen "sexual harassment training" and others used by the Academic Dean and Provost for a meeting with the Board of Visitors.

The Role of the Armed Services Committees in Shaping Strategic Policy for the Twenty-First Century

Researcher: Associate Professor Willie Curtis
Sponsor: Naval Academy Research Council (OMN)

A number of congressional experts have suggested that the analysis of the role of Congress in the defense policy process has not been sufficiently examined. John Lindsey's recent book, *Congress and Nuclear Weapons*, is a major contribution to the profession. However, his study focuses on Congress as a whole, although he does acknowledge that "the Committees that exercise the most influence over nuclear weapons policy are the defense committees of the House and Senate." The researcher is examining the role and influence of the Armed Services Committees on the development of nuclear strategy, strategic weapons development and strategic force structuring for the Twenty-First Century.

The study focuses on the Armed Services Committees' members and their staff. Information is being collected through interviews, examination of public records, documents, and the committee process in assessing defense policy proposals. This provides the data and materials necessary to understand the role of these committees during the 1970's and 1980's. This research is designed to contribute to the scholarship David C. Kozak and others have suggested is missing in the political science discipline. A journal article is forthcoming during the 1993-1994 academic year.

Reasonable Disagreement: Two Senators and the American Political Dilemma

Researcher: Professor Karl A. Lamb
Sponsor: Naval Academy Research Council (OMN)

This research asks the following three questions: What are the roots of political stalemate in America? Is the U.S. Senate a principle cause, or only a victim, of this policy paralysis? Can the new presidential administration expect to alter significantly the system? The answers are sought by examining the careers and daily lives of two senators--Paul Sarbanes (D-Maryland) and Richard Lugar (R-Indiana). These two senators usually vote on the opposite sides of most important questions, and the source of their contrasting values can be traced in their biographies. While the policy positions taken by Lugar and Sarbanes often represent alternatives between which the nation must choose, the quest for advantage by their separate parties prevents a definitive choice, with political stalemate the result. In designing the separation of powers, the Founding Fathers sought to prevent tyranny, not promote efficiency. But they did not anticipate policy paralysis. The purpose of this research is to provide a thorough understanding of the Senate, including both its limits and its possibilities, by examining the actions of these two senators during the presidencies of Jimmy Carter, Ronald Reagan, and George Bush. Then, the level of analysis will be raised to consider the nature of the contemporary Senate in the context of the relationship between Congress and Presidents Bush and Clinton.

The Role of Cognition, Information, and Cultura! Variables in Intuitive Analyses and Expert Predictions of International Co. flict Situations: The Case of U.S. Policies and Recent Political Chang:s in South Africa

Researcher: Professor Helen E. Purkitt
Sponsor: Naval Academy Research Council (OMN)

The reforms instituted by the deKlerk government since 1990, the Bush administration's decision to repeal the Anti-Apartheid Act in 1991, and the breakdown of the CODESA negotiations in the face of continuing violence in South Africa during 1992, resurrected a longstanding debate in the United States about U.S. interests and the optimal means to influence the course of events in South Africa. From a basic research perspective, the most interesting aspects of this recent policy debate relate to similarities and differences in the assumptions, analytical dimensions, and information perceived to be relevant among policy analysts and policy makers in both the U.S. and South Africa. There is some evidence that certain systematic differences in recent policy analyses completed by Americans and South Africans, which are often explained by reference to "cultural differences," can more accurately be explained using insights from information processing theory. The objective of research completed during 1991-1992 was to collect additional expert judgmental data from analysts and politicians in both the United States and South Africa in order to identify similarities and differences in the basic assumptions, analytical dimensions and type of information used by analysts across a wide ideological spectrum in the United States and South Africa. The researcher is attempting to assess the usefulness of insights from more general research on how political "experts" and "novices" in two very different cultural settings intuitively process information and conduct intuitive analyses of on-going political problems. During August 1992, the researcher conducted interviews in South Africa. The virtual protocols from 12 of these interview sessions which asked interviewees to engage in a "think aloud" exercise have been coded, analyzed, and summarized in a technical report.

Human Rights, Democratization and American Security

Researcher: Assistant Professor Stephen D. Wrage
Sponsor: Naval Academy Research Council (OMN)

The objective of the research is to investigate and explain the changes in U.S. human rights policies toward former Warsaw Pact states to respond to the tumultuous changes of 1987-1990. During this time many regimes that Reagan and Bush administration policy makers had declared "totalitarian" and incapable of reform suddenly were overthrown and replaced with governments that proclaimed themselves nascent democracies. These developments brought a new policy challenge: not to pressure regimes to open up but rather to support them in their apparent movement toward democracy. Paradoxically, as the new governments proved both difficult to influence and much less stable than the old, the net impact on American security became ambiguous. The ultimate goal of the research is to clarify this ambiguity by producing a theoretical framework for assessing the impact of movements toward democratization in eastern Europe and the former Soviet Union on American security. The project will be presented at the American Political Science Association convention in Washington in August 1993.

Search and Seizure, the Supreme Court, and Criminal Justice in America

Researcher: Assistant Professor Priscilla H. M. Zotti
Sponsor: Naval Academy Research Council (OMN)

This research is a normative analysis of the exclusionary rule as a tool of crime control and due process during the 1960's, 1970's, 1980's, and 1990's. The case of Mapp v. Ohio provides a framework for understanding the larger forces at work. The researcher is analyzing the development of law on three levels: (1) nationally, the tension throughout the last three decades caused by the turbulent balancing of the rights of the accused and those of society, (2) locally, what impact the changes in search and seizure law have had on police, prosecutors, and the judiciary. What changes in training and procedure have resulted? And, (3) personally, what impact the change in law has had on the individuals involved. Mapp v. Ohio provides the lens to view structural, institutional, and personal change.

Ethics and the Law: Using the Case Method of Instruction

Researcher: Assistant Professor Priscilla H. M. Zotti
Sponsor: American Bar Association's Commission on College and University Nonprofessional Legal Studies

The purpose of this research grant was to develop ethics case scenarios and supplemental course material which recreate a reality and teach Midshipmen concepts and theory through specific events. The goal was to create a framework for the presentation of difficult and often sensitive issues in the context of moral and ethical choices. The collection of these case studies and supporting materials will be shared with other service academies, meeting the over-arching goal of ensuring that all young officers understand the ethical and moral responsibilities and burdens that accompany their oath of office. The final report of this grant will be published by the American Bar Association's Commission on College and University Nonprofessional Legal Studies.

Affirmative Action: A Synthesis of Competing Compensatory and Distributive Justifications

Researcher: Midshipman 1/C Patrick M. Keane, USN
Adviser: Assistant Professor Priscilla H. M. Zotti
Sponsor: Trident Scholar Program

This project sets forth a new model for dispensing justice in affirmative action litigation. Analyzing all decisions by the High Court, this research traces the development and use of two different models for affirmative action cases, compensatory justice, and distributive justice. Gleaning the benefits from each model while attempting to avoid their drawbacks, the author creates a new model that may better "fit" the true goal of compensating those who are victims of discrimination.

Balancing Congressional Needs for Classified Information:
A Case Study of the Strategic Defense Initiative

Researcher: Midshipman 1/C Carter W. Page, USN
Adviser: Professor Stephen E. Frantzich
Sponsor: Trident Scholar Program

This research project examines the nature of the balance of secrecy between the executive and legislative branches of government. In the preliminary segments of this investigation, the commonly accepted explanations for the position of the secrecy balance are thoroughly addressed. For example, legal arguments as well as the grounds of national security are used by players in this struggle to shift the balance in their direction. This study will reveal that these elements, as well as a number of other popular arguments, have only a slight effect on the contemporary secrecy balance. We will also postulate that secrecy is a political question which has variably shifted in favor of the Congress and the

Executive throughout American history.

Once it is determined that the question of the secrecy balance is political in nature, it will then be possible to place this balance into the context of the political struggle over the Strategic Defense Initiative (SDI). This case study will allow us to examine secrecy on two separate levels. First, we will question the way secrecy changes the overall balance of power in the political arena. Once it is determined that secrecy is an important element of power, we may then consider how the balance of secrecy may be variably shifted between the Congress and the executive branch.

Independent Research

American Public Policy

Researchers: Professor Charles L. Cochran and Assistant Professor Eloise F. Malone

This project reflects increased interest in public policy which is heightened by a stagnant economy and a government that is increasingly perceived as unresponsive. In the spring of 1992, McGraw Hill offered a contract to the aforementioned scholars to write a public policy textbook. The book uses "public choice theory" as its conceptual framework, and is also used to teach the complex nature of the public policy process. The first chapters outline the policy making context (i.e. our federal system) and policy making methodology. Later chapters address substantive public policy issues such as health

care, housing, education, the environment, and the criminal justice system and involve substantive comparative policy analysis with other countries, especially Canada, Japan, and Western European nations. The book is unique in its emphasis on the role of economic theory and models in understanding how public policy decisions are made (discussing the difference between public and private goods, the problems of scarcity and rational self-interest). Currently 9 of 14 chapters have been written for an August 1993 submission date.

The Congressional Game

Researcher: Professor Stephen E. Frantzich

A number of different perspectives can be used to analyze the U.S. Congress. The game analogy invites the observer to focus attention on the

players, rules, strategies, and the winners and losers. This research involves developing a game-based approach to organizing the literature on Congress.

It will extensively use the actual words of members of Congress as they use the game analogy in their daily work. The resulting book will be a comprehensive text on the Congress which utilizes the game analogy to expand student understanding. The first draft of the resulting book has been accepted for publication by W.S. Brown publishers. It is being co-authored by Steven Schier of Carleton College. The book will go into production this summer. In its final form, it will be augmented with computerized and video-based teaching materials that will be integrated with the game theme.

American Government: The Political Game

Researcher: Professor Stephen E. Frantzich

This co-authored college level textbook using the game analogy to analyze American politics is currently in the final stages of production. Its twenty-two chapters look at each institution and process of American government by focusing on the players, rules, strategies, and the winners and losers. Aside from using the game analogy as an organizing theme, the text emphasizes the impact of new technologies on the political process. It is a full-fledged standard American government text that has been extensively reviewed by peers and classroom tested. The co-author is Stephen Percy of the University of Wisconsin-Madison. Aside from the basic text, the project has included for researching and developing a teachers guide, student guide, and supporting video tape. The text will be published in October 1993.

Analysis Package for the Congressional Database

Researcher: Professor Stephen E. Frantzich

The Congressional Database is a disk-based data package of information on the members of the 102nd Congress. This 90-page monograph outlines college-level analysis projects for students in political science courses. It will be distributed with the database on its completion in the summer of 1993. The first draft has been written and it is now going through student testing and faculty evaluation. The exercise package will allow students to analyze such factors as the social background of Congress, congressional voting patterns, congressional career patterns, and congressional committee assignments. The database simplifies the data collection efforts of students and allows them to focus their efforts on developing and testing interesting hypotheses. The database will be updated on a yearly basis as will the exercises. This project was supported by the National Planning and Consulting Corporation.

Electronic Service Delivery and Congress I

Researcher: Professor Stephen E. Frantzich

New information technologies such a computer databases and video teleconferencing have significant potential for improving Congress' internal workings. This piece of contract research based on extensive interviews and data analysis outlines the opportunities and pitfalls for Congress' use of these new technologies. Completed in November 1992, this analysis has become part of a larger project of OTA analyzing the role of new technology for improving governmental operations and services. The major findings indicate that Congress should move in two directions. Expanded use of videoconferencing would both improve efficiency and improve congressional information gathering. The development of a unified computerized congressional public policy database has the potential of improving Congress information management as well as better serving the public access interests of the American citizenry. This project was supported by the Office of Technology Assessment.

Electronic Service Delivery and Congress II

Researcher: Professor Stephen E. Frantzich

The Markle Foundation, in response to numerous calls for Congressional Reform in 1992, invited a number of scholars to speculate on some of the potential areas for reform. New information technologies such as computer databases and video teleconferencing have significant potential for improving Congress's ability to serve the needs of and interact with its constituents. This piece of contract research, based on extensive interviews and data analysis, outlines the opportunities and pitfalls for Congressional use of these new technologies for improving interaction with constituents. Completed in January 1993, this analysis has become part of a larger project among congressional scholars to suggest reforms in the congressional process, and this research has become a source document for the Joint Committee on the Reform of Congress. Based on this research, the author was asked to testify before the committee staff and contribute to a special report on the opportunities Congress now faces.

A European Security Framework for the Future

Researcher: Associate Professor Gale A. Mattox

The research done for a paper prepared for presentation at the American Political Science Association annual conference in Chicago analyzes the dramatic changes which have taken place in Europe since 1989 and the effect of those changes on the security regimes in Europe. While the North Atlantic Treaty Organization (NATO) safeguarded the continent and, by extension, the United States during the Cold War, the new era places very different requirements on security alliances and even puts into question the raison d'etre for NATO. The paper reviews the debate and then addresses the existing NATO structure as well as the Western European Union, Conference on Security and Cooperation in Europe (CSCE), the European Community, and a new organization as contenders to assure European security in the future. It concludes that NATO, with the very substantial changes that have taken place within the structure, remains the most appropriate framework in the short term for European security, but that a more inclusive framework will be necessary for the future in order to respond to the needs of the Central Europeans and even the new states carved out of the former Soviet Union.

Information Processing and the Formulation of Public Policy

Researcher: Professor Helen E. Purkitt

Political choice often aims at directing or shaping public policy formulations through informational transactions. These transactions depend on information search and processing. Since information processing is an important feature of cognitive psychology and given that public policy has characteristics in common with problem-solving activity, it might prove fruitful to link together these two domains. From this linkage we may be able to determine what the current strengths and weaknesses are in the making of public policy and what might be done to improve public policy formulations. In demonstrating how to link public policy with information processing we discuss four key components: (1) the formulation of public policy, (2) key information variables, (3) information processing, and (4) two public policy issues in terms of information processing (welfare policy and affirmative action).

Concerning public policy, the issue of how political players may make high quality political choices seems unusually important. If one posits varying degrees of scarcity of resources--i.e., of a finite system with limits to the ability to sustain growth and distribute advantages--how political actors, including advisors, solve the puzzle of "who

gets what, when and how" (Lasswell) concerns all of us. And these issues present formidable puzzles for policy makers to attempt to solve. How these puzzles are solved and to what end generate political controversy. Typically, this controversy is replete with erroneous data and victimized by processing biases. We believe that improvement in these areas is necessary if we are to improve the quality of public policy. There is for many of us a tendency to want immediate satisfaction and efficacious effects from political decision-making which leads to a short-run mentality. This public view is complemented by elected officials who tend to believe that they have an uncanny ability to read the public's mind which leads them into efforts at

"quick fixes." These efforts are tempered by the activities of vested interests, sometimes called special interests, who typically have a high stake investment in the public policies currently in place. These interests are not likely to change their demands without some form of quid pro quo. What is needed is a model which leads to better subjective judgments. But we cannot simply program a computer to make our choices for us, so we need to learn how to analyze problems more effectively if we wish to develop more useful public policies. In this paper, we want to indicate how information processing errors lead to the formulation of suboptimal public policies and what might be done to improve these policies.

Considerations in Japan's Military Planning for the Future

Researcher: Professor Robert L. Rau

Japan, since 1990, has deployed two military task forces overseas and is debating changing its constitution to reflect greater interest and participation in international events. This research outlines major changes in Japanese security policy which are ongoing, and the research also highlights the many dilemmas of a political, logistical, or cultural nature which hinder the remilitarization of Japan. A group of issues, events, and developments

have been identified which will signal (if and when they occur) greater pressure on Japan's political leaders to strengthen Japan's capacity to use military force. The results of this research were forwarded to the Mobil Shipping and Transportation Company, the project's sponsor, and a rewritten paper will appear in *Proceedings* in the Summer of 1993.

The New World Order and the General Assembly

Researcher: Professor Rodney G. Tomlinson

This research examines the issues and alignments in the United Nations forty-sixth year (1992). It examines issues, their saliency, and the alignment shifts through time. The principal collaborator in

this effort is Assistant Professor Steven Holloway, St. Francis Xavier University, Antigonish, Nova Scotia.

The Politics of Human Rights

Researcher: Assistant Professor Stephen D. Wrage

This research examines the history of the human rights issue in American politics and American foreign policy. It begins with the drafting of the United Nations Universal Declaration of Human Rights and continues through the human rights challenges to Henry Kissinger's leadership posed by

Congress in the early 1970's, the initiatives launched and largely retracted by the Carter administration in the late 1970's the redefinition of human rights by the Reagan administration in the early 1980's and the melding of human rights and world order Politics by the Bush administration in recent years.

A book length manuscript has been submitted to St. Martin's Press.

A Monograph of Augustus and the Roman Imperial Cult

Researcher: Assistant Professor Stephen D. Wrage

This monograph studies the uses of symbols and myths for propaganda purposes in the struggle between Octavian and the assassins of Julius Caesar and later in the battles between Augustus and Antony for control of the empire. This is the first piece of a larger study of symbol and myth in politics. This monograph has been submitted to American Philological Association monograph series.

Target Selection in the Gulf War

Researcher: Assistant Professor Stephen D. Wrage

This research studies the targeting choices made in the air war portion of the Gulf War with an eye to discrimination and proportionality. The resulting article from this research is under consideration by *Ethics and International Affairs*.

The Design and Redesign of the Rule of Exclusion: Search and Seizure Law in the United States and Canada

Researcher: Assistant Professor Priscilla H. M. Zotti

Balancing the rights of accused with government's concern for Security and the rights of the whole is a timeless challenge which all democratic societies face. Using Herbert Packer's models of the criminal justice process, this project compares the changes in search and seizure law which have occurred in the United States and Canada. The issue of what to do with evidence tainted by an illegal search and seizure clearly illustrates the tradeoffs countries are willing to make concerning citizen-police encounters. The alterations noted comprise more than a shift in policy; they reveal changes in the basic premises of the respective criminal justice systems. This research will be published in the Fall 1993 volume of The Canadian Review of American Studies.

Research Course Projects

A Study of the Problems in Northern Ireland in the Context of Ethnic Conflict

Researcher: Midshipman 1/C Laura Ann Bajor, USN
Adviser: Associate Professor Gale A. Mattox

The purpose of the project was to study the struggle in Northern Ireland as a classic case of ethnic conflict. Utilizing scholarly literature on the subject of ethnic conflict, researching the history and present status of the problems in Northern Ireland, and looking at what the future possibly holds for the area, the researcher attempted to apply the theories of ethnic conflict. Based on the research, she

concluded that a solution to the Northern Ireland problem will only come when those who possess the power to bring about change feel that the circumstances have become so bad that they must swallow their pride and sacrifice some of their sacredly-held positions. A plan to assure power-sharing by the involved groups could guarantee the rights and opportunities of all and could be at least the first step in a solution.

The American Moral Posture

Researcher: Midshipman 1/C Henry D. Brown, USN
Adviser: Assistant Professor Stephen D. Wrage

The researcher addressed the problem of how the United States should choose where and when to engage its military forces in the post-Cold War world. He reviewed the record of American military interventions in the 19th and 20th centuries and discerned cyclical patterns of interventionism alternating with isolationism. He examined and rejected isolationist options available at this point, arguing that the United States, as the world's wealthiest nation, has too much property abroad and derives too great benefit from an open and orderly international system of free trade and peaceful relations to abandon internationalism and retreat into a merely continental or hemispheric future. Settling on an internationalist destiny for the U.S., he got down to cases and examined four kinds of justifications for American interventions in Somalia and in the former Yugoslavia. He consulted articles in a variety of journals including *Parameters*, *Foreign Affairs*, and *Ethics and International Affairs* and he charted the assumptions and principles that lay behind the various arguments. In the conclusion of his 30-page study he outlined his own original synthesis of the positions taken in several of the articles.

Ethical Standards for Military Interventions

Researcher: Midshipman 1/C Scott A. Cooper, USN
Adviser: Assistant Professor Stephen D. Wrage

The researcher addressed the central problem in military intervention: how can the people of one state justify crossing the borders and interrupting the national life of the people of another state? How can it be right to use violence to compel another country to do what your country feels is right? He reviewed the arguments of seventeenth and eighteenth century writers on state sovereignty, including Grotius, Kant, and Mill, then turned to contemporary scholars of ethics and international affairs including Michael Walzer, Bernard Trainor, and William O'Brien. He used a communitarian argument derived from Michael Walzer's *Just and Unjust Wars* to construct the moral justification for unilateral intervention in the Balkans and produced a 40-page paper which was submitted to a graduate student essay contest conducted by the journal *Ethics and International Affairs*.

An Analysis of the Past, Present, and Future of the Czechoslovak Federation

Researcher: Midshipman 2/C Grant G. Goodrich, USN
Adviser: Professor Arthur R. Rachwald

The purpose of this study was to better understand the complexities of political situation on Czech Republic and Slovakia, two emerging nations in Europe that after some seventy-five years decided to dissolve their federation. In addition to political issues this research focused on the economic

viability of both countries as independent units, with a special attention devoted to rapid economic changes toward privatization and a free market economy. Analysis of this nation-building processes is a unique story and a tremendous lesson on the politics of development, the opportunity to examine the dynamics of destruction and creation of a state and nation in the heart of Europe.

Congressional Oversight Over the Intelligence Community

Researcher: Midshipman 2/C Patrick R. Hooper, USN
Adviser: Professor Charles L. Cochran

This is an analysis of the evolution of Intelligence oversight by the Congress of the United States. Congressional oversight has evolved from complete control in the Revolutionary War to permitting the professional intelligence community almost complete freedom during the cold war years. As the cold war waned, so did foreign policy consensus. Congressional attempts to reassert control resulted in opposition by Presidents who had become used to exercising control without interference. The publication of various abuses of authority by the intelligence community resulted in a determined Congress insisting on a greater oversight role. Presidential resistance resulted in the Iran-Contra scandal. After developing the historical and constitutional background, the researcher analyzed the problem of achieving the greatest efficiency in intelligence commensurate with the requirements for oversight in a democratic system.

Post-Soviet Constitutional Development in Russia

Researcher: Midshipman 1/C Sean G. Kelliher, USN
Adviser: Professor Arthur R. Rachwald

The primary purpose of this study was to examine current constitutional developments in Russia. After successful transition in leadership and the strengthening and reform of basic principles of constitutional government, Russian policy makers proceeded to elaborate new legal framework for their country. It has been proposed that the Russian government be composed of three branches: legislative, executive, and judicial. In addition to horizontal separation there is also vertical division of power because the Russian state will retain its federal character. The legislative power will be vested in the State Duma, the executive power in the popularly elected for five years president, and the Constitutional Court will have the highest judicial authority, including the power to judicial review. However, the draft document reads more like a propaganda device. It often uses dramatic statements similar to the old communist pronouncements. Also, many legal loopholes exist in the present draft, particularly in the area of horizontal and vertical distribution of power.

Soviet Link to the Attempted Assassination on Pope John Paul II

Researcher: Midshipman 1/C Sean G. Kelliher, USN
Adviser: Professor Arthur R. Rachwald

Given the known facts about the attempted assassination on Pope John Paul II in May 1980, there should be no surprise that the Soviet KGB was behind the entire scheme. This study describes what happened and why and then goes on to show how, contrary to the official Soviet and Bulgarian statements, communists agents masterminded the attempted assassination. The Polish Pope was regarded in Moscow as a "destabilizing" factor in global correlation of forces because of his ability to mobilize population in East European countries. Terroristic solution was consistent with Moscow's

tradition to liquidate uncomfortable individuals and Western practice of closing their eyes and ears to

Soviet dealings with Eastern Europe.

The Irish Republican Army: An Examination of a Terrorist Organization

Researcher: Midshipman 1/C Kelly S. Kinsella, USN
Adviser: Associate Professor Gale A. Mattox

The purpose of this independent research project is to examine the role of the Irish Republican Army as a terrorist organization in the dispute between Irish Catholics and British Protestants in Northern Ireland. Areas researched include the development of the Irish Republican Army at the turn of the Twentieth Century, the Eastern Rising of 1916, and the split between the Irish Republican Army and the more radical Provisional Irish Republican Army in 1970. Most of the focus of the final paper is on the aspects of the Provisional IRA that qualify it as a terrorist organization, and how it manages to fund its activities and gain world-wide support for its freedom-fighting cause despite these acts of terrorism. The most recent information regarding the activities and funding of the Provisional IRA was obtained through the use of the Lexis-Nexis network, recent journals, and other research papers published by the Defense Intelligence College and the Army War College. This independent research project shows that the Provisional IRA is in fact a terrorist organization determined not to stop fighting until British control in Northern Ireland no longer exists.

The European Community and the Challenge of Expansion

Researcher: Midshipman 1/C John R. Miles, USN
Adviser: Associate Professor Gale A. Mattox

The researcher traced the historical background of the European Community (EC) from its formation in 1950 to the signing of the Maastricht Treaty and the subsequent debate of the treaty. The paper highlights the economic and security issues now confronting the EC and analyzes the ability of the political framework of the EC to meet the challenges those issues will pose for the future. Those challenges will include the econor ic problems caused by massive migration, unemployment, environmental degradation, and a whole range of social issues such as workers' benefits; internal and external security threats; and the full range of problems brought about by an anticipated enlargement of the EC (particularly to include Central Europe as well as other countries). While acknowledging the challenges of widening and deepening of the Community within a radically changed global environment, the researcher concludes that the dream of a single market and united Europe are still in the future, but clearly no longer beyond the reach of the EC.

From START and Beyond: The Strategic Arms Reduction Talks and the Future of Nuclear Arms Control

Researcher: Midshipman 1/C Michael Sean Mollohan, USN
Adviser: Professor Arthur R. Rachwald

The existing situation of international stability and nuclear arms control is becoming more complex by the hour. The current START II agreement is the first step forward, and will serve as hedge against any changes in political orientation in Moscow and other nuclear post-Soviet states. If Russia were to ratify and implement the new treaty, it would send a message to other former republics still possessing nuclear weapons. This step would serve to alleviate their current concern about Moscow's imperial

intention.

The possibility to further reduce the arsenals of the superpowers to the level of 1,000 to 2,000 warheads each would curb proliferation and would entice non-nuclear states to forsake nuclear ambitions. Moreover, such reductions would secure the process of reform and democracy in both the former Soviet republics and Russia, as Moscow is a "nuclear heir" and the most prominent military, political and economic actor among the newly independent states. For this reason it is imperative that START is a springboard to further negotiations. These future negotiations will not be limited to Russia and the United States only, but must involve many other nuclear and potentially nuclear nations, to eliminate the incentives for possession and use of weapons of mass destruction.

Governmental Aid to Religious Schools: Defining the Line of Neutrality

Researcher: Midshipman 2/C Michelle E. Montgomery, USN
Adviser: Assistant Professor Priscilla H. M. Zotti

This paper explores the debated issues and numerous court casesinvolving violations of the Establishment Clause in governmental aid to secondary schools. After analyzing the various interpretations by the Court and the varied application of the Lemon test, this paper proposes a new test of neutrality in order to achieve clarity with regard to Establishment Clause questions.

The National Front in France: A Legitimate Opposition Party

Researcher: Midshipman 1/C Michael P. Summers, USN
Adviser: Associate Professor Gale A. Mattox

The shape of opposition politics has undergone a significant transformation in the post World War II era. With the defeat of fascism in the war, one would expect the radical elements in Europe to lose popularity. However, various current issues, such as immigration, high unemployment, declining standards of living, and nationalism in the face of serious economic strains have facilitated a rise in support for more extreme parties across the continent. One party that attracts extensive media coverage, even in the United States, is the Front National (FN) in France. An understanding of the nature of oppositions in Europe allows an analysis of the FN. The researcher's conclusion is that the party has the effect of increasing social awareness of the issues it targets, but it will not become a significant governmental power. The first part of the paper defines the nature of opposition politics in Europe, the second part describes the French political system and a background of the FN, and the final section analyzes the party in the opposition framework.

The Fourth Branch: The Power Struggle Between the Media and the U.S. Government

Researcher: Midshipman 1/C J. Clay Trantham, USN
Adviser: Associate Professor Gale A. Mattox

The researcher examines the tremendous power the mass media wields in today's society. Government leaders have realized that Congress and the justice system are fueled by the public. To be successful, the Executives must bring into conformance their policy and public opinion--either by adjusting that policy or reshaping the public opinion. It is found that policy is the easiest to adjust, therefore the media is unable to set the agenda. If public opinion is being reshaped, then the media is most likely being manipulated by a skillful elected or appointed official. This hypothesis is analyzed by looking at

the historical relationship between government officials and the many forms of media. The paper also focuses on the current media power-players, and how their influence is employed.

Publications

CURTIS, Willie, Associate Professor "The Decline in Relevance of Extended Deterrence in U.S.-European Security," *Viewpoints*, Winter 1992, pp. 16-29.

The premise on which the United States and the Soviet Union based their respective defense policies for the past four decades collapsed in 1989, and as the decade came to a close, the United States and the Soviet Union appeared to have entered into a period characterized by reduced tension and cautious cooperation. It was obvious by the beginning of the 1990's that events taking place in Central and Eastern Europe would compel U.S. national security planners to rethink the role that nuclear weapons would play in the defense of the new Europe. The post-war strategic order in Europe, which had been bipolar in nature and dominated by the two superpowers no longer existed and the ending of the Cold War quite logically would reduce Europe's reliance on the U.S. nuclear guarantee. This article advances the argument that the more specific threat of Soviet expansionism has been replaced by new threats of ethnic conflict, a potential surge in East-West migration from an increasingly unstable Commonwealth of Independent States (former Soviet Union) and several Eastern European states. The negative implications for regional security have radically changed the security relations between the United States and its European allies. This article will advance the arguments that : (1) Europe is now just one in a series of regional security problems rather than a strategic one for the United States; (2) the assumption that extended deterrence credibility must be predicated on maintaining large stockpiles of tactical and battlefield nuclear weapons in Europe is no longer valid, and; (3) the declining role of nuclear weapons in extending deterrence to Western Europe will provide an opportunity for a dramatic reduction in the number of strategic nuclear weapons in the nuclear arsenal.

FRANTZICH, Stephen E., Professor, "The Congressional Voyeur: Peeping Toms Through the Congressional Window," *'Off the Video Record'*

Conference Proceedings, West Lafayette, Indiana: Purdue University, 1992, pp. 7-28.

The availability of a video record of the U.S. Congress has a potential "unlocking effect" on congressional research by providing access to data which was once unavailable. This paper outlines the nature of the video data which exists in no other form. It lays out a series of basic research questions using this data and explicates the research designs which could be used. The paper also discusses some of the dangers one must consider before relying on the video record.

FRANTZICH, Stephen E., Professor, book review, "Knowledge Power and the Congress," *Political Science Quarterly*, 107 (Fall 1992), pp. 563-564.

Information processing is the "core technology" of the U.S. Congress. The book reviewed is a flawed, but interesting collection of essays which attempt to analyze the role and adequacy of information available to Congress. The review was the product of a conference on the bicentennial of the Congress and reflects perspectives drawn from both the academic and working worlds.

PURKITT, Helen E., Professor, editor, *Annual Editions. World Politics 1993/4*, Sluice Dock, Connecticut: Dushkin Press, 1993.

This book is a collection of 57 articles about recent issues and trends in international affairs. The book is organized into eight sections covering major current issues in each regional subsystem of the world and key policy issue areas related to the global economy and international arms proliferation. This set of readings is designed to be used as a supplementary text in introductory courses in International Relations, U.S. foreign policy, and national security issues.

RACHWALD, Arthur R., Professor, "Poland: Integration and Security Relations with Europe," *Transition to Democracy in Poland*, ed. Richard F. Staar, New York: Macmillan, 1993, pp. 235-256.

The Poles managed to pioneer revolutionary changes throughout the former Soviet bloc without excessive bloodshed. The three years since 1989 have been utilized to establish bilateral agreements as well as regional security structures with all neighbors. However, the prospects for democracy and a free market economy in Poland depend on membership in the European Community and NATO. The EC membership appears to be more or less certain by the year 2003, but conditions for NATO membership remain unclear. Together with other nations of Central and Eastern Europe, Poland is now in a "gray zone" between Atlantic Europe and the highly volatile, newly independent states of the former Soviet Union. Left on its own, the entire region is likely to become a victim of ethnic unrest and faces prospects of another subordination to Moscow.

TOMLINSON, Rodney G., Professor, *Reference Guide to the 47th (1992) United Nations General Assembly Rollcalls*, Washington: United States Department of State, March 1993.

This is a reference document that summarizes voting records of the members of the United Nations for the Forty-Seventh (1992) General Assembly. All rollcalls are studied and cataloged according to agenda, date, location, major and minor subjects, and important related incidents and issues in world affairs. A short descriptive passage is prepared and rollcall votes for each member are appended. A series of cross-reference indexes are prepared to provide quick look by dates, resolution number, agenda number, location, and topical keywords. This document is published for use by members of the U.S. Diplomatic corps and U.S. missions abroad to facilitate research into positions taken by the nations to which they are accredited.

WRAGE, Stephen D., Assistant Professor, co-author, "Human Rights and Nuclear Proliferation: Some Comparisons," *Security Studies*, Summer 1993, p. 4.

The article compares initiatives designed to prevent nuclear proliferation and to protect human rights.

It develops the idea that most successful initiatives in both fields have shared the characteristic of being indirect, ie, of working through third parties in the target countries who might for some reason have an interest in preventing proliferation or halting human rights abuses. This article is also to appear in Fall 1993 in *The Proliferation Puzzle: New Perspectives on the Spread of Nuclear Weapons*.

ZOTTI, Priscilla H., Assistant Professor, "Ethics and the Law. Using the Case Method of Instruction: The Police and Rodney King." *Proceedings* of the National Conference on Ethics in America, February 1993, p. 413.

This case study sets forth the facts of the arrest and beating of Rodney King. In doing so, the reader is asked to evaluate the conduct of King, the police officers on the scene, the media, and leadership of the Los Angeles police department. What responsibilities and obligations do the police have to the public at large in their service to combat crime? What role do police training and administrative standards of behavior play in creating an ethical climate? What responsibility does the media have in disseminating information about such volatile events? What responsibility does Rodney King have in these events? The reader is asked what could have been done to prevent the actions which occurred? Furthermore, what can be done to prevent such violent police-citizen encounters in the future?

ZOTTI, Priscilla H.M., Assistant Professor, book review of *Terrorism in Europe* by Antonio Vercher, *The Law and Politics Book Review*, April 1993, p. 413.

This short essay explains Vercher's thesis and indicates its strength and weaknesses to the reader. Vercher's comparative analysis of certain key features of common law and civil law systems-- internment, exclusion orders, and the use of informers for example, help the reader understand the different kinds of problems polities face in dealing with terrorism.

Presentations

COCHRAN, Charles L., Professor and Eloise F. MALONE, Assistant Professor, "A Rawls-Nozick Approach to Policy Choice: A Framework for Analysis," The Midwest Political Science Association 1993 Meeting, Chicago, Illinois, 15-17 April 1993.

FRANTZICH, Stephen E., Professor, "The Congressional Voyeur: Peeping Toms Through the Congressional Window," "Off the Video Record" Conference, West Lafayette, Indiana: Purdue University, 13-15 November 1992.

FRANTZICH, Stephen E., Professor, "Using C-SPAN in the Classroom," C-SPAN Seminar for Professors, Washington, DC, 15-16 July 1992, 20-21 August 1992, 4-5 January 1993.

FRANTZICH, Stephen E., Professor, "Leadership in the Technological Senate," C-SPAN, Washington, DC, 20 November 1992.

FRANTZICH, Stephen E., Professor, "Technology and the Constitution," Anne Arundel County Gifted and Talented Teacher's Seminar, Annapolis, Maryland, 15 July 1992.

KEANE, Patrick, Midshipman 1/C, USN, "The Future of Affirmative Action on the Rehnquist Court," The Southwestern Political Science Association convention, New Orleans, Louisiana, 17-20 March 1993.

MALONE, Eloise F., Assistant Professor, "Quebec Independence U.S. Policy Position," The American Council for Quebec Studies Biennial Conference, Montreal Canada, 19-22 November 1992.

MALONE, Eloise F., Assistant Professor, "Canada: A Failure of Federalism--An Application of Riker's Model," The International Studies Association 34th Annual Conference, Acapulco, Mexico, 23-27 March 1993.

MATTOX, Gale A., Associate Professor, "New Directions for International Security," Opening Lecture for Women in International Security Summer Symposium, St. Mary's College, St. Mary's City, Maryland, 25 June 1992.

MATTOX, Gale A., Associate Professor,

"Challenges to International Security," Washington Center, U.S. Department of Labor, Washington, DC, 9 August 1992.

MATTOX, Gale A., Associate Professor, "Approaches to International Security," American University, Washington, DC, 10 November 1992.

MATTOX, Gale A., Associate Professor, "Ethnic Conflict Resolution in Eastern Europe," Women in International Studies/MacArthur Project, Prague, Czech and Slovak Federal Republic, 18-20 September 1992.

MATTOX, Gale A., Associate Professor, "Grants and Fellowships Workshop," Women in International Studies Summer Symposium, St. Mary's College, St. Mary's City, Maryland, 27 June 1992.

MATTOX, Gale A., Associate Professor, "German Unification: Interest Rates, Yugoslavia, and the Eurocorps," International Security Studies Section Annual Conference, Phoenix, Arizona, 6 November 1992.

MATTOX, Gale A., Associate Professor, "The Future German Role in Europe and European Security," American Political Science Association Annual Convention, Chicago, Illinois, 6 September 1992.

MATTOX, Gale A., Associate Professor, "Discord and Collaboration in a New Europe," Dickinson and Army War College Conference, Dickinson College, Carlisle, Pennsylvania, 29-31 October 1992.

MATTOX, Gale A., Associate Professor, "U.S. Policy and European Security Arrangements," Intersessional Lecture Series, University of Delaware, Newark, Delaware, 19 January 1993.

MATTOX, Gale A., Associate Professor, "Merging East-West Concerns: Issues and Problems," International Studies Association Annual Conference, Acapulco, Mexico, 25 March 1993.

MATTOX, Gale A., Associate Professor, "Organization and Structure of U.S. Foreign Policy," Washington Center, Washington, DC, 17 May 1993.

POLITICAL SCIENCE

MATTOX, Gale A., Associate Professor, "European Security after Maastrict," Washington Center, Washington, DC, 25 May 1993.

MATTOX, Gale A., Associate Professor, "Germany after Unification," Council on Foreign Relations, Washington, DC, 5 May 1993.

MATTOX, Gale A., Associate Professor, "U.S. Foreign and Defense Policy with Respect to European Interests," Salzburg Seminar, Austria, 29 May to 5 June 1993.

PURKITT, Helen E., Professor, "Regional Security Issues: Africa," Third Annual Conference for young Women (and Men) Interested in Careers in International Security," Sponsored by Women in International Security (WISS), St. Mary's College, St. Mary's City, Maryland, 30 June 1992.

PURKITT, Helen E., Professor, co-presenter, "Information Processing and the Formulation of Public Policy," Fifteenth Annual Meeting of the International Society of Political Psychology, San Francisco, California, 5 July 1992.

PURKITT, Helen E., Professor, "How Political Experts and Novices Represent Problems in Contemporary South Africa," School of International Relations, University of Southern California, Los Angeles, California, 6 November 1992.

RACHWALD, Arthur, Professor, "Security Issues in Central Europe," Embassy of Poland, Washington, DC, 9 October 1992.

RACHWALD, Arthur, Professor, "Polish-German Relations after the Unification," American Association for the Advancement of Slavic Studies meeting, Phoenix, Arizona, 20 November 1992.

RACHWALD, Arthur, Professor, "Poland: Integration and Security Relations with Europe," Hoover Institute, Palo Alto, California, 23 November 1992.

RACHWALD, Arthur, Professor, "Poland: National Security and the Question of Integration

into the European Community and NATO," International Studies Association Annual Conference, Acapulco, Mexico, 23-27 March 1993.

RACHWALD, Arthur, Professor, "Global Implications of Political Instability in Russia," International Institute for Global Peace, Tokyo, 8 March 1993, National Defense Academy, Yokosuka, 10 March 1993, Sofia University, Tokyo, 11 March 1993, Kyoto University, Kyoto, 15 March 1993.

RACHWALD, Arthur, Professor, "Security Issues of Central Europe," Slavic Research Center, Hokkaido University, Sapporo, 15 March 1993.

RACHWALD, Arthur, Professor, "The Visegrad Group in the Emerging European Order," Conference on Central Europe, University of Maryland, Washington, DC, 30 April 1993.

RACHWALD, Arthur, Professor, "Central Europe as a 'Gray Zone' of Regional Security in Europe," Stanford University and Hoover Institute seminar for Central and East European Diplomats, Palo Alto, California, 17 May 1993.

RAU, Robert L., Professor, "Considerations in Japan's Military Planning for the Future," International Studies Association/West Conference, Phoenix, Arizona, 5-7 November 1992.

WRAGE, Stephen, Assistant Professor, "Human Rights Policy in the Reagan Administration," International Studies Association Annual Convention, Acapulco, Mexico, 25 March 1993.

WRAGE, Stephen, Assistant Professor, "Human Rights and Nuclear Proliferation: Some Comparisons," Stanford Conference on Proliferation, Palo Alto, Califronia, 5 February 1993.

WRAGE, Stephen, Assistant Professor, "Ethics and the Secret Bombing of Cambodia," University of Virginia, Charlottesville, Virginia, 27 October 1992.

WRAGE, Stephen, Assistant Professor, "Democratization and American Security," Mershon Center at Ohio State University, Columbus, Ohio, 20 May 1993.

Division of
Mathematics and Science

Chemistry

Professor Mark L. Elert
Chair

The scope of research activity in the Chemistry Department was broadened considerably this year with the addition of two new faculty members: Assistant Professor John W. Bodnar in biochemistry and Assistant Professor Robert S. Pomeroy in analytical chemistry. Both have already established vigorous research efforts at the Academy, giving midshipmen increased opportunity for research experience in these two important areas of chemistry.

Midshipmen 1/C Michael P. Keith and James E. Brown completed Trident Scholar research projects in the Chemistry Department this year, with Midshipman Keith winning the Office of Naval Intelligence Harry E. Ward Prize for the best Trident Scholar project of the year. Ten other chemistry majors completed research projects during the academic year under the guidance of faculty mentors.

The Chemistry Department has a long tradition of collaborative research efforts with Navy laboratories and other private and government institutions. This year collaborative projects are underway with the Naval Research Laboratory, the Naval Surface Warfare Center, the Naval Medical Research Institute, NASA, the National Oceanic and Atmospheric Administration (NOAA), the Universities of Delaware and Maryland, AT&T Bell Laboratories, and Eastman Kodak. Other faculty members have obtained external grant support from the National Science Foundation and the Army Research Office.

Research interests of the faculty range from fundamental studies of molecular structure and dynamics to practical investigations of chemical problems in forensics, corrosion, and hazardous material handling. This wide range of research activity helps to strengthen and invigorate the chemistry curriculum of the Naval Academy, preparing our graduates for the technical challenges they will encounter in the Fleet.

Sponsored Research

Multidisciplinary Studies on Biological Information Systems

Researcher: Assistant Professor John W. Bodnar
Sponsor: Naval Academy Research Council (ONR)

A fertilized egg contains all the biochemical information necessary to determine the identity of an adult animal, and the process of organismal development depends on a series of biochemical events to express that information into structural components of the organism. The information for development is stored in a hierarchy of forms: molecular information in DNA; cellular information in cell nuclei; and organismal information in tissues throughout the growing organism. Therefore, understanding the biochemistry of organismal development will require an integrated knowledge of biochemical pathways and compartmentalization of information at the molecular, cellular, and organismal levels.

The purpose of this research is to collate current knowledge on information storage in biological systems to form an integrated theory of organismal development. This research combines theory, computer simulation, and laboratory experimentation to link together literature from diverse biological disciplines--forming new, integrated theories to be tested by computer simulation and new experimentation.

Specific aims of this project are: (1) Completion of experiments on the intranuclear localization in

time and space of viral DNA information within the cell nucleus as a function of the cell cycle; (2) Theoretical studies on temporal regulation of biological information during the cell cycle and viral lytic cycle; and (3) Completion of a computer simulation on the sequence of steps in regulation of genetic information during the growth of fruit fly embryos.

Kinetics of The Reaction Al(^{2}P^o) + H$_2$O Over an Extended Temperature Range

Researcher: Assistant Professor Mark L. Campbell
Sponsor: Naval Research Laboratory, Code 6110

The temperature dependence of the reaction Al(^{2}P^o) + H$_2$O has been investigated over the temperature range 298 - 1174 K. Aluminum atoms were produced by photodissociation of Al(C$_2$H$_5$)$_3$ and were detected by laser-induced fluorescence. Curved Arrhenius behavior was observed, and the rate constants can be described by the expression k(T) = (1.9 ± 1.5)x10^{-12} exp[(-(0.88 ± 0.44 kcal mol^{-1})/RT] + (1.6 ± 0.7)x10^{-10} exp[-(5.7 ± 0.9 kcal mol^{-1})/RT] cm^{3}s^{-1}, where the uncertainties represent ± 2σ. At room temperature the rate constant is pressure independent in the total pressure range 10 - 110 Torr (Ar buffer). The rate constant expression is interpreted in terms of two metathesis reactions with different Arrhenius parameters, one yielding AlO and the other AlOH. These results have been submitted for publication in *The Journal of Physical Chemistry*.

Oxidation Reactions of Ti(a^{3}F) from 300 to 600 K

Researcher: Assistant Professor Mark L. Campbell
Sponsor: Naval Research Laboratory, Code 6110

Gas phase kinetics have been investigated for the reactions of Ti(a^{3}F) with O$_2$, N$_2$O, NO, CO$_2$, and SO$_2$ from 300 to 600 K and with NO$_2$ from 300 to 500 K. Titanium atoms were produced by the photolysis of TiCl$_4$ at 248 nm and were detected by laser-induced fluorescence. Arrhenius expressions obtained for these reactions at a buffer gas pressure of 20 Torr are:

$$k(O_2) = (1.69\pm0.41)x10^{-10}exp(-(11.6\pm0.8 \text{ kJ/mol})/RT) \text{ cm}^3\text{s}^{-1},$$

$$k(N_2O) = (1.74\pm0.44)x10^{-10} exp(-(14.3\pm0.9 \text{ kJ/mol})/RT) \text{ cm}^3\text{s}^{-1},$$

$$k(NO) = (3.28\pm0.69)x10^{-11}exp(-(3.62\pm0.71 \text{ kJ/mol})/RT) \text{ cm}^3\text{s}^{-1},$$

$$k(CO_2) = (7.0\pm1.6)x10^{-11}exp(-(14.9\pm0.8 \text{ kJ/mol})/RT) \text{ cm}^3\text{s}^{-1}, \text{ and}$$

$$k(SO_2) = (1.70\pm0.33)x10^{-10} exp(-(2.66\pm0.64 \text{ kJ/mol})/RT) \text{ cm}^3\text{s}^{-1}.$$

The rate constant of Ti with NO$_2$ was found to be temperature independent from 300 to 500 K with a value of (9±4)x10^{-11} cm^{3}s^{-1}. Quoted uncertainties are ±2σ. With the exception of Ti + O$_2$, all reactions were investigated as a function of pressure. Only the reactions of Ti with NO and CO$_2$ were found to depend on the argon buffer gas pressure. Termolecular rate constants at 300 K were determined to be (5.8±2.6)x10^{-31} cm^{6}s^{-1} and (3.5±1.0)x10^{-32} cm^{6}s^{-1} for NO and CO$_2$, respectively. Our results support an electron transfer mechanism whereby charge separation occurs in the course of Ti abstracting an oxygen atom from the oxidant; i.e., the reactant goes through a polar transition state. These results have been submitted for publication in *The Journal of Physical Chemistry*.

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Quartz Crystal Microbalance Study of Mercury Deposition on Platinum

Researcher: Associate Professor Graham T. Cheek
Sponsor: Naval Research Laboratory, Code 6171

This continuing research project involves the electrodeposition of mercury in an attempt to obtain a very smooth film for X-ray investigations as well as for study of reduction pathways of organic compounds at mercury surfaces. Mercury surfaces were prepared by reduction of mercurous nitrate at platinum-coated (230 nm) quartz crystals, monitoring the frequency during the process. As reduction proceeded, the frequency decreased considerably (by several kHz), far more than expected for simple mass deposition. This observation suggests a high degree of strain on the film as mercury amalgamates with the platinum.

Upon disconnection of the working electrode, the frequency returns to within a few hundred hertz of the initial frequency, indicating that the strain occurs mostly at the beginning of the deposition process. Based on the deposition of different amounts of mercury, the composition of the film appears to be PtHg. By proceeding to relatively more negative potentials during deposition, the film surface was transformed from dull gray to a very shiny appearance. When potential control was interrupted, however, some beading of the mercury occurred.

Synthesis of a Sterically Hindered Tetraazaporphyrin: Tetraanthracenotetraazaporphyrin

Researchers: Assistant Professor Jeffrey P. Fitzgerald and
Midshipman 1/C Patrick R. Hittle, USN
Sponsor: Army Research Office

Porphyrins are naturally-occurring, macrocyclic compounds which catalyze many of the various bioreactions of molecular oxygen. A structurally similar family of macrocycles, tetraazaporphyrins (TAPs), are expected to have similar catalytic properties. However, on reaction with oxygen, planar iron-substituted TAPs form catalytically inactive u-oxo dimers. Formation of the u-oxo dimer requires close approach of the two macrocycles and it was our hypothesis that TAP bearing bulky peripheral groups would not be able to form the inactive dimer. Dicyanoacetylene was prepared and reacted with anthracene to yield a substituted maleonitrile which was successfully cyclized into tetraanthracenotetraazaporphyrin. Spectroscopic evidence was obtained which indicates that the iron complex of this ligand is sterically prevented from forming a u-oxo dimer.

Hazardous Materials Minimization Program (Shipboard Hazardous Materials)

Researcher: Professor Frank J. Gomba
Sponsor: Carderock Division, Naval Surface Warfare Center,
Annapolis Detachment

Using a Hazardous Material Inventory System Program on CD ROM, supplied by DoD, Hazardous Materials Worksheets are being prepared for all materials used aboard ships and submarines involving any hazardous materials. This will be used in conjunction with developed software for easy retrieval of information on any hazardous material used by the U.S. Navy aboard ships/submarines, to include information on proper handling and health hazards of such material. In addition, recommendations are being made for alternate materials which can be used to replace the

hazardous materials.

Preparation and Reactions of Bicyclo[3.3.0] Octanes

Researcher: Assistant Professor Debra K. Heckendorn
Sponsor: Naval Academy Research Council (ONR)

Many terpenoid natural products contain γ-butyrolactones or cyclopentanes as essential structural features. In some systems, these rings are crucial for biological activity. For this reason, strategies for preparation of these types of substrates are of great interest. The ability to prepare both types of rings with various substitution patterns in a facile, short synthesis from a common intermediate is particularly appealing.

The focus of this project is the development and optimization of a general methodology for the synthesis of γ-butyrolactones and their derivatization, both to substituted lactones and to cyclopentane rings. The methodology being developed uses a key intermediate which can selectively be converted to a variety of lactones. This key intermediate is a cyclohexene ring which can be prepared with excellent regio- and stereochemical control through a Diels-Alder reaction.

Ozonolytic cleavage of substituted cyclohexenes with an oxidative work-up gives diacids. These diacids undergo facile lactonization with alcohol substituents located at the gamma position. To date, this strategy has been successful in the preparation of a variety of lactones with substituents at the β and γ positions. The preparation of such substituted lactones requires only three synthetic steps.

Further studies utilize these lactones as intermediates in cyclopentane formation. If the lactone contains a carboxylate substituent, Dieckman cyclization yields a bicyclo[3.3.0]octane ring system. The simplest of these ring systems can be prepared in excellent yield. Investigation into the chemistry of this ring system has been undertaken. Alkylation of the system occurs under mild conditions. Reactions at the ketone are also facile.

One area of interest is the conformational analysis of such bicyclic systems. NMR investigation of a variety of derivatives has been coupled with molecular modeling. The results of this study show that conformational mobility is strongly affected by substitution on the bicyclic ring. Introduction of alkyl groups on the ring leads to an increase in steric strain and also lead to greater conformational mobility. Derivatives which have substituents away from the ring show that only one conformation is present. These results open the possibility of using bicyclic rings as stereochemical control agents.

Synthesis of Inorganic Molecular Solids with Unusual Electrical or Magnetic Properties

Researcher: Assistant Professor William B. Heuer
Sponsor: Naval Academy Research Council (ONR)

Recent efforts in this project area have focused on the synthesis and characterization of a series of metal dithiocroconate complexes. Complexes with Cu(II), Ni(II), Pd(II), Pt(II), Fe(III), Co(III) and Cr(III) have been prepared and characterized by elemental analysis, IR, UV-VIS, ^{13}C-NMR, and cyclic voltammetry. Single crystal X-ray structures of the Fe(III) and Co(III) complexes have also been completed. Electrochemical and ^{13}C-NMR measurements on the Pd(II) and Pt(II) complexes suggest that they are strongly associated in solution;

full X-ray structural characterization of these complexes is necessary to determine if the association persists in the solid state. In general, the metal dithiocroconate complexes synthesized to date have oxidation potentials that are ca. 200 mV more positive than those of the analogous $M(mnt)_x$ (mnt = maleonitrile-dithiolate) complexes, making them the strongest acceptors of all known metal dithiolene complexes. This resistance to oxidation has hampered initial efforts to electrocrystallize partially-oxidized salts of these complexes with

fixed-valence alkylammonium cations. Several salts with readily oxidized organic heterofulvalene donors have been prepared, however preliminary investigations suggest that these materials are not highly conducting. Future efforts will be directed towards preparation and characterization of analogous series of complexes based on dicyanomethylene-substituted derivatives of the dithiocroconate ligand.

Synthesis of Low Molecular Weight Pyridine Analogue of poly(p-Phenylene)vinylene

Researcher: Assistant Professor William T. Lavell
Sponsor: Naval Academy Research Council (ONR)

Coupling of 3-bromopyridine with 2-vinylpyridine under Heck reaction conditions led to the formation of trans-1-(3-pyridyl)-2-(2-pyridyl)ethylene. Reaction of 2-methyl-5-bromopyridine, prepared by halogenation 2-methylpyridine, with 2-vinylpyridine under similar conditions led to the formation of trans-1-(2- methyl-5-pyridyl)-2-(2-pyridyl) ethylene; subsequent reaction with pyridine-3-carboxaldehyde in refluxing acetic anhydride led to the formation of trans, trans-3,2'-5',2"-pyridinevinylene.

These materials are small, dipolar analogues of poly(p-phenylene)vinylene. They are currently being characterized by a variety of physical methods for interesting spectroscopic and electrical properties. For example, an acetonitrile solution of trans,trans-3,2'-5'2"-pyridinevinylene has a fluorescence band in the visible region at substantially shorter wavelength than the corresponding carbocyclic compound. Additionally, cyclic voltammetry indicates that the two new materials have reversible, less cathodic 1-electron reduction potentials relative to stilbene. The synthesis of higher molecular weight pyridine analogues is under investigation. This project was *also sponsored by the AT&T Bell Laboratories.*

Synthesis of Buckminsterfullerenes

Researchers: Assistant Professor Joseph F. Lomax and
Midshipman 1/C Kevin Boykin, USN
Sponsor: National Science Foundation

A device for making buckminsterfullerenes was made. A standard operation procedure was developed for the synthesis. Techniques for isolating the product were refined. Characterization is anticipated by X-ray powder crystallography, elemental analyses, optical properties and especially the low temperature audio frequency complex impedance measurements.

Synthesis and Characterization of Hafnium Exchanged β"-Aluminas

Researchers: Assistant Professor Joseph F. Lomax and
Midshipman 1/C John Poole, USN
Sponsor: National Science Foundation

Ion exchange has been accomplished upon the reaction of $HfCl_4$ with Na-β"-alumina. Changes have been noted in the X-ray fluorescence spectroscopy and optical properties. This work extends the work on zirconium exchanged β"-alumina and it is anticipated that the compounds made will have interesting low temperature audio frequency complex impedance characteristics.

Electron Density Determination Using X-ray Diffraction

Researcher: Assistant Professor Wayne H. Pearson
Sponsor: Naval Academy Research Council (ONR)

The technique of single-crystal X-ray diffraction has long been used to determine the positions of atoms in crystals. This method of structure determination has been a mainstay tool of research in the areas of chemistry, physics, and material science for the better part of the twentieth century. For the past thirty years, it has been recognized that X-ray diffraction not only is sensitive to atom positions but to the aspherical distribution of electron density in crystals. The aspherical component of electron density is a result of the bonding interactions between atoms in crystals. Thus, the X-ray experiment provides a probe for the study of valence electron distributions in crystals.

The original focus of this project was to complement the theoretical work of Midshipman 1/C James Barney who completed his Trident project during the academic year 1989-90. His original work involved the calculation of the degree of pi bonding in a series of para-substituted nitrobenzenes. The results of these calculations indicated that significant through-resonance pi bonding would be present in para-nitroaniline while virtually no through-resonance pi bonding would take place in the meta isomer. Crystals of both compounds were to be grown and studied by X-ray techniques. Unfortunately, the crystals which were obtained from these compounds were not of sufficient quality to allow these studies to take place. However, two other studies were undertaken in an effort to analyze the electron density distributions in two very different chemical systems. The first study involved the structure determination and preliminary electron density study of the bis-phosphine iron dimer. This material was synthesized by photolysis in the lab of Dr. Joyce Shade. The previously unknown structure was determined by X-ray diffraction techniques and refined to an agreement factor of $R(F) = 5.6\%$. The area of interest in terms of bonding is the possible Fe-Fe bonding region. The difference Fourier maps of the structure show no build up of electron density in the Fe-Fe region.

The second study involved the replacement of Na^+ ions in lithium substituted B" - Alumina with Zr^{3+} ions. These crystals were grown in the lab of Dr. Joe Lomax. Extensive X-ray data sets were collected on both the parent compound and the Zr^{3+} substituted compound at -127 degrees C. Subsequent refinement of both structures shows that the substitution of Zr^{3+} has a definite effect on the site preference of the Na^+ ions which correlates with differences in electrical conductivity of these two materials.

The Development of Diffusional Kinetics Models for Describing Ligand/Receptor Dynamical Interactions

Researcher: Associate Professor Boyd A. Waite
Sponsor: Naval Medical Research Institute

A kinetic model has been developed for describing soluble ligand interactions with surface receptors, including both specific and non-specific binding. A novel aspect of this model is the incorporation of a "rebounding" species, i.e., a ligand which has re-entered the extra-cellular medium surrounding the cell surface after having encountered a surface site, and which will re-encounter the cell surface. Elementary steps and corresponding rate laws are proposed for ligand/surface receptor associations, bound-complex dissociations, and "rebounding" species associations. Two-dimensional diffusion of species within the membrane is also incorporated in the model with analogously defined "rebounding" species. Elementary steps and rate laws are proposed for surface bound interactions (associations, dissociations, and rebounding associations). Future work will describe calculations based on this model for particular ligand/receptor systems, such as the interleukin-2 receptor/ligand system in T-cell proliferation signal transduction.

Photochemically Induced Transformations
of Transition Metal Complexes

Researcher: Midshipman 1/C James E. Brown, USN
Advisers: Associate Professor Joyce E. Shade, and
Assistant Professor Wayne H. Pearson
Sponsor: Trident Scholar Program

Photolysis of the dinuclear complex $[(n^5\text{-}C_5H_5)Fe(CO)_2]_2$ in $CHCl_3$ results in the formation of $(n^5\text{-}C_5H_5)Fe(CO)_2Cl$ through intermediate 17-electron radicals of the form $(n^5\text{-}C_5H_5)Fe(CO)_2$. The photolyses of the related diphosphine-bridged compounds, $[(n^5\text{-}C_5H_5)Fe(CO)]_2\text{-u-DPPX}$, where DPPX = DPPM $(Ph_2P)_2CH_2$, DPPE $(Ph_2P)_2C_2H_4$ and DPPP $(Ph_2P)_2C_3H_6$ have been conducted in chloroform using ultraviolet light. In contrast to the simple iron carbonyl dimer, the phosphine bridged diiron compounds yield a golden dimeric product which contains the phosphine ligand intact as a bimetallic bridge. In the case of the DPPM and DPPE systems, incorporation of chloride ligands from the solvent into the isolated products is not observed. However, formation of a formyl substituent on one of the previously symmetrical cyclopentadienyl rings has been confirmed spectroscopically through infrared analysis, multinuclear NMR and X-ray diffraction studies. The proposed mechanism for the formation of such a complex appears to involve a radical intermediate and follows a modified Reimer-Tiemann reaction. Such a pathway is believed to be unprecedented in the photo-chemistry of bimetallic complexes. In the case of the DPPP complex, the golden product that is isolated also contains the phosphine

substituent as a bimetallic bridge. The bidentate ligand, however, appears to be too long to allow a metal-metal bond and the resulting product contains symmetrical cyclopentadienyl rings on each iron center along with the chloride ligand and a carbonyl group.

In the synthesis and purification of the analogous ruthenium dimer, $[(n^5\text{-}C_5H_5)Ru(CO)]_2\text{-u-DPPM}$ and the attempted synthesis of the DPPE compound, $[(n^5\text{-}C_5H_5)Ru(CO)]_2\text{-u-DPPE}$, there resulted two ruthenium monomers of the form $(n^5\text{-}C_5H_5)Ru(Cl)DPPX$. Nuclear Magnetic Resonance spectra ^1H, ^{31}P and ^{13}C have been obtained for both monomers. In addition, the structures of the two compounds have been verified using X-ray crystallography. Further synthetic studies are underway to produce the desired dimers in high yield. The complete results of the project were presented at the Semon Undergraduate Research Symposium at Kent State University in April 1993. A preliminary report on this project was made at the XVth International Conference on Organometallic Chemistry in Warsaw, Poland in August 1992 and also at the 204th National Meeting of the American Chemical Society in Washington, DC in August 1992.

Interleukin-2 Signal Transduction: A Diffusion-Kinetics Model

Researcher: Midshipman 1/C Michael P. Keith, USN
Adviser: Associate Professor Boyd A. Waite
Sponsor: Trident Scholar Program

A diffusion-kinetics model for the interactions between interleukin-2 and each of its T-cell surface receptors (α and β) is presented. This model is unique in that it considers both three dimensional ligand-receptor interactions and two dimensional interactions between cell surface-bound species. Elementary rate laws are developed for initial encounters, rebounding interactions, and

dissociations of free ligands and receptors. Analogous rate laws are written for membrane bound species which undergo similar initial associations, rebounding interactions, and dissociations. A set of kinetic equations is proposed for a system consisting of two independent monovalent receptors and one monovalent ligand, simulating the interaction of the α and β

interleukin-2 receptor molecules of the human T-cell with the lymphokine interleukin-2. Autocrine and paracrine growth and combinations of the two are studied by modifying the appropriate experimental parameters. Experimental associative and dissociative rate constants are determined for important T-cell surface species.

This research was awarded the Trident Scholar Prize for the most outstanding project among all of the Trident Scholars for the 1992-1993 academic year.

Independent Research

Investigation of Proton-Donating Ability of 1-Ethyl-3-Methylimidazolium Chloride

Researcher: Associate Professor Graham T. Cheek

The two-electron reduction of benzophenone in the basic aluminum chloride : 1-ethyl-3-imidazolium chloride melt has been found to produce the alcohol (benzhydrol) upon hydrolytic workup. The reduction forms a ketyl initially (first electron transfer, oxyanion), followed by a carbanion (second electron transfer). The goal of this new research project is to determine whether or not the molten salt cation, which possesses hydrogen atoms on the imidazolium ring as well as on alkyl ring substituents, can donate protons to carbanion intermediates formed during benzophenone reduction. Upon hydrolyzing a melt (after benzophenone reduction) with deuterium oxide (instead of water), uptake of only one deuterium atom was observed in the product. Since the ketyl oxygen (oxyanion) is complexed by aluminum chloride in the melt and is later hydrolyzed to the alcohol by formation of -OH (-OD) bond in the water (deuterium oxide) workup, this result indicates that the second hydrogen is obtained from the melt cation. Further work is in progress to determine which hydrogen atom is involved, although previous work has shown that the C-2 hydrogen is particularly acidic, exchanging with deuterium oxide under rather mild conditions.

Spectroscopy of Irradiated Ices

Researcher: Associate Professor Robert F. Ferrante

This project involves FT-IR spectroscopic studies of irradiated water or methanol ice and ice/guest mixtures maintained at very low temperatures (near 20 K). Samples are subjected to proton irradiation, and the resulting matrices analyzed (both mid- and far-IR) to determine the nature of the unstable or stable fragments and/or new compounds, the particular form (phase) of the ice matrix appearing after radiation exposure, and the thermal processing of the sample. Guest species are chosen from simple compounds (e.g., CH_3OH, H_2CO, NH_3, CH_4, CO, N_2, CO_2, etc.) that are representative of molecules of relatively high abundance in space, or that have been shown experimentally to be associated with comets. Samples were deposited on Al or amorphous silicate substrates, which are more representative of the presumed refractory particulate matter found in comets. Other samples involved the *in situ* production of silicates from low-temperature proton irradiation of SiH_4/H_2O/guest mixtures. Product species show some evidence of being characteristic of exposure dosages and other formative conditions. The goal of this research is to examine current hypotheses regarding the nature of

ice layers on comets, and the changes in these layers after exposure to ionizing radiation such as that present in the interstellar medium.

A significant new result was the observation that deposition of water or methanol vapor, or mixtures, on amorphous silicate surfaces immediately formed crystalline, rather than amorphous ice layers. This phenomenon had not been observed before, since other researchers use polished metal substrates, resulting in amorphous ices on low-temperature deposition. The significance lies in the fact that the

phase (amorphous or crystalline) of the ice layer in comets and icy satellites of the outer planets has been used to explain the mechanisms of formation and processing, and the energetics of other phenomena associated with these bodies. The natural formation of crystalline ice on the presumed silicate grains of these objects may require re-evaluation of such interpretations.

This research was conducted at NASA's Goddard Space Flight Center in Greenbelt, Maryland.

Synthesis of Redox- or Photochemically-Active Ionophore Complexes

Researcher: Assistant Professor William B. Heuer

Redox-active molecules possessing ion-binding functionality have been proposed as components of molecular ion sensors or controlled-release systems for ions. This project focuses on the preparation of a series of redox-active or luminescent transition metal complexes incorporating pendant crown-ether groups to provide the requisite ion-binding function. Two new functionalized crown-ether type ligands have been designed and the feasibility of synthesizing these ligands is currently being investigated. One ligand incorporates an external ethylene-1,2-dithiolate moiety directly into a crown ether ring; this sulfur-donor ligand group on the periphery of the crown ether should form a variety of redox-active, chelate transition metal complexes. The close proximity of the metal-based redox site

and the ion-binding site of the crown ether should promote a strong electronic interaction between the sites. A second ligand appends a crown ether group to the periphery of a 1,10-phenanthroline (phen) ligand. α-diimine ligands of this type are known to form strongly luminescent ruthenium complexes, and it is anticipated that ion binding will strongly influence the emission properties of the complex. Huckel molecular orbital calculations indicate that the 5, 6 positions of the phen ligand have the largest coefficients in both the HOMO and LUMO, making these the optimal sites for substitution. Synthesis of this hybrid crown ether ligand will proceed via a cyclization reaction involving either 1,10-phenanthroline-5,6-diol or 1,10-phenanthroline-5,6-epoxide.

Expert System Development for a Charged-Coupled Device Based Atomic Emission Spectrometer

Researcher: Assistant Professor Robert S. Pomeroy

The excellent performance of Charge-Coupled Device (CCD) detection in analytical spectroscopy-- particularly in low light level spectroscopies such as fluorescence, chemiluminescence and Raman--has been well documented. In addition to a large number of detector elements (pixels), low noise characteristics, and excellent quantum efficiency, CCDs also exhibit a large dynamic range and high linearity, making them applicable to techniques where more light is available. The application of CCDs to atomic emission spectroscopy (AES) has

been slow, however, due to their tendency to bloom. The recent advent of large format, antiblooming CCDs now provides all of the advantages of CCDs for AES detection without the limitations associated with blooming.

An atomic emission spectroscopic system using an inductively coupled plasma source, a custom echelle spectrograph, and a 1280 by 1024 pixel antiblooming CCD has been constructed. The spectrometer was built using only readily available components and provides a wavelength coverage from 180 nm to 700

nm. The high resolution of the system is demonstrated by the near baseline resolution of the Cd 228.802 and the As 228.812 nm emission lines.

As software tools are continually added to aid in performing rapid computer-assisted analysis, the goal is to provide a platform for the development of a complete AES expert system. Current software tools include a wavelength-assignment algorithm which calculates and displays a continually updated wavelength, to the nearest 0.01 nm, by tracking the movement of a mouse controlled cursor. The system also includes software for building and maintaining elemental databases and an algorithm for determining peak areas based on a spectral line fit which successfully rejects background contributions with no *a priori* knowledge of the sample composition. Additionally, qualitative and standardless quantitative analysis routines and graphics interfaces are included to aid the operator in analysis and with the design and development of experimental protocols. This project was sponsored by Eastman Kodak.

Initial Investigations into the Use of a Scientific Charge-Coupled Device Based Spectroscopic System for Spectrometric Determinations in Sea Water

Researcher: Assistant Professor Robert S. Pomeroy

The study of geochemical cycles in the ocean requires sensitive and selective methods of analysis, because many of the constituents of interest in sea water are at trace levels in a complex matrix. Land based analysis allows for the use of sophisticated, state-of-the-art instrumentation but necessitates that the sample be transported back to the lab. Shipboard analyses overcome many of the limitations faced by land based measurements while simultaneously providing for near real time analysis. However, shipboard environments are hostile to delicate, complex instruments; space on board ship is often at a premium; and the atmosphere is at times corrosive and humid. The power supplied to the instruments is poorly regulated and the motion of the ship in heavy seas and the vibration from the engines can quite literally shake instruments to pieces. The rigors of the shipboard environment demand that the instruments be compact and rugged with a high degree of automation. Developments of solid state array detectors and new optical spectroscopic components now make it possible to assemble compact, rugged, power efficient spectroscopic systems with precision rivaling that of benchtop instruments. These systems represent the first step towards developing sensitive instrumentation for remote autonomous sensors, with future development towards *in situ* analysis.

This investigation will focus on fiber optic based optical system design, detector characteristics and modes of operation that will result in a shipboard instrument capable of both sensitive fluorometric and high precision absorbance measurements for the spectroscopic determination of oceanic pH. Special consideration will be given to detector characteristics such as device format, full well capacity, and digital dynamic range for high precision absorbance measurements.

Spectrophotometric Determination of pH

Researcher: Assistant Professor Robert S. Pomeroy

Highly accurate measurements of pH (± 0.002 pH units) is attainable using calorimetric indicators and a photodiode array based spectrophotometer. Measurement of the pH to this degree of accuracy is necessary in order to properly study the carbon dioxide system in the oceans and how it is influenced by gas exchange and biological production. The photodiode array system was chosen because of its rugged design and its rapid multiwavelength acquisition over a broad spectral

range. (Single spectra covering 700 nm can be obtained in seconds.) Cresol Red and Thymol Blue where chosen for initial studies as they have pK_as in the pH region encountered in sea water. This study focuses on the instrumental, chemical and thermodynamic factors that influence the precision and accuracy of determining the pH spectrophotometrically. This project was supported by National Oceanographic and Atmospheric Administration.

The Thermodynamics of the Dissociation of Hepes in Synthetic Sea Water

Researcher: Assistant Professor Robert S. Pomeroy

"Tris" is likely the most popular buffer for use in biological applications and in the determination of oceanic pH. However, "Tris" is a fairly poor buffer below pH = 7.5 and has a high pH temperature coefficient. For this reason Good (Biochemistry, 5, 2, 467-477 1966) initially explored alternative buffer materials for biological research. Good, et al., first described the preparation and pK_a of HEPES. As a potential buffer in oceanographic research, HEPES has a pK_a in a range that should nicely complement that of "Tris" buffer and has the added advantage of a much smaller temperature coefficient, making it a better choice as a standard reference material. In order for HEPES to be of any use for calibration of sea water pH, the dissociation constant must be determined in a sea water matrix. This work determines the dissociation constant of HEPES in synthetic sea water over a salinity range of 25 to 45 and over a temperature range from 273.15 to 318.15 K using a specially designed standard hydrogen electrode cell. The conditional constants based on a "total" hydrogen ion scale are being determined. This research was supported by the National Science Foundation.

Studies in Spontaneous Ignition

Researcher: Professor Charles F. Rowell

This project arose from the observation that the existence of spontaneous ignition as a cause of casualty fires was widely accepted, yet studies of the conditions under which spontaneous ignition occurs had not been reported in several decades. Earlier studies were, at best, anecdotal. After the building of a chamber that permitted light exclusion and temperature control in an outdoor setting, the project moved to study the significance of parameters such as porosity of cloth, percent loading with linseed oil or other polymerizable material, extent of exposure to air before being clustered together, importance of exposure to fluorescent lights during use before storage, etc. Data was gathered by embedding a thermocouple in the bundle of rags and recording both the temperature and appearance of the system by use of a television camera which recorded date and time automatically. While much data has been gathered and some surprising facts have come to light, the study has not reached a point that permits definitive conclusions. Control of some of the factors has been difficult and further study will require solving some of these engineering problems.

Diphosphenes and Diarsines in Cluster Synthesis

Researcher: Associate Professor Joyce E. Shade

The purpose of this project is to investigate the synthetic pathways possible for the generation of cyclopentadienyl-ruthenium complexes containing n^2-diarsene ligands. Complexes of this type which

contain chromium, molybdenum, and tungsten have been investigated by several research groups. Recently, complexes containing zirconium, niobium, and tantalum as the metal centers have been successfully synthesized, isolated in very small yields and characterized by Nuclear Magnetic Resonance and X-ray diffraction studies. These complexes are interesting due to the fact that the di-hapto ligand would be isolobally analogous to an organic olefin.

Preliminary experimental work has been started and the $[Cp^*RuCl_2]_n$ starting material has been synthesized in reasonable yields. Synthesis of the cycloarylarsine, cyclo-$(TolAs)_{5,6}$, has been accomplished following the reported literature methods that begin with p-toluidine. In this scheme, the p-toluidine is converted to p-toluidine diazonium perfluoroborate which is then converted to p-tolylarsonic acid using As_2O_3. Final isolation of the cyclic tolylarsine is accomplished through a reduction of the acid solution using hypophosphorous acid. The arsenotoluene product which is obtained is a mixture of both the five- and six-membered rings in various ratios.

Reactions of the cyclotolylarsine with the polymeric ruthenium species mentioned above have been attempted under various experimental conditions.

Because of the polymeric nature of the metal starting material and the mixed stoichiometry of the arsine species, it has been difficult to determine the exact reaction conditions needed to insure reaction of the compounds rather than decomposition of one or both of the starting materials. To date, definitive results have not been obtained, but work on the project is still in progress. This research was supported by Professor Arnold L. Rheingold of the University of Delaware.

Photochemical Study of Cyano-Isocyanide-Phosphine Complexes of Iron and Ruthenium

Researcher: Associate Professor Joyce E. Shade

The chemistry of carbonyl-cyano-phosphine complexes of iron has been studied extensively for the last ten years. In general, reflux or photolytic reaction conditions have been employed to initiate the loss of a carbonyl (CO) group from cyclopentadienyl-iron-carbonyl starting materials with a subsequent inclusion of a phosphine or phosphite ligand on the metal center. The resulting complexes obtained in these studies, however, all contain at least one carbonyl group. The purpose of this research was to prepare a series of anionic, neutral and cationic cyano, mono- and bisisocyanide complexes for reaction with phosphine or phosphite groups under photolytic conditions.

Photolysis of the monoisocyanide complex, $(n^5$-$C_5H_5)Fe(CO)(CN)(CNCH_3)$, in the presence of a slight excess of triphenylphosphine at room temperature gave the desired product $[(n^5$-$C_5H_5)Fe(CN)(CNCH_3(PPh_3)]$ with loss of one equivalent of carbon monoxide. However, two additional products have been obtained: $(n^5$-$C_5H_5)Fe(CNCH_3)_2(CN)$ and $(n^5$-$C_5H_5)Fe(CN)(PPh_3)_2$. Similar results were obtained with a variety of phosphine, phosphite, arsine and antimony ligands. Several of the reaction products have been isolated from the fairly clean reaction mixtures and a variety of spectral data have been obtained to verify their identity. Further purification and characterization of these compounds is continuing. In addition, trends of reaction product yields with bulk and basicity of ligand are being studied. Effect of ligand identity (both on the metal prior to photolysis and as an incoming group), wavelength of the photolysis lamp and temperature of the reaction mixture are being studied as they affect the reaction products obtained. Anionic and cationic starting materials are being investigated under a variety of reaction conditions in order to analyze the system for any trend which might develop as a function of complex charge. A collaborative effort was established with Professor Antony Rest at The University in Southampton in an effort to conclusively identify the reaction intermediate(s). The results of this work have been very promising and the identity of the reaction intermediate has been postulated, as a result of low-temperature matrix isolation studies conducted by Professor Rest. Work on the project is continuing with a shift in focus to the analogous ruthenium species. Manuscripts on the synthetic portions of the project as well as the spectroscopic matrix work are being prepared and final spectral

data is being obtained for inclusion in the papers.

Research Course Projects

Electrochemical Studies of Indigoid Systems

Researcher: Midshipman 1/C R. Vincent Barthel, USN
Adviser: Associate Professor Graham T. Cheek

Electrochemical studies of the indigoid systems indigo, indigo carmine, and Tyrian Purple have been carried out, principally in alkaline solutions. The electrochemical behavior of Tyrian Purple is of particular interest because it was used in ancient times as a dye, being converted to the leuco, or reduced, form during processing. The electrochemical activity of these systems is due to the conjugated diketone structure, giving rise to reversible electron transfers. Redox potentials for the Tyrian Purple system have been determined in an effort to discover the most likely reducing agent to be employed in the ancient process. The electrochemical parameters for such common reducing agents as lead, tin, and iron have been investigated in this regard. It has been found that the tin system is thermodynamically the most powerful reducing agent in the examples studied, although other factors also play a role in providing a reducing agent of practical utility.

The results of this research were presented at the 57th Annual Intercollegiate Student Chemists Convention, held at Juniata College, Huntingdon, Pennsylvania, on 17 April 1993.

Nuclear Magnetic Resonance Order Parameters in Uniaxial Systems for the Carbon-Carbon Bonds of Alkyl Chains

Researcher: Midshipman 2/C Keith E. Hartman, USN
Adviser: Assistant Professor Ronald E. Siatkowski

All of the obtainable information on molecular orientational order may be described by a second rank tensor known as an order parameter tensor. A flexible molecule like a uniaxial liquid crystal is composed of rigid subunits, such as phenyl rings, methylene moieties, etc. Each moiety will have its own order parameter tensor. The order parameter tensor can be defined by the order parameters of the molecule. Order parameters are numbers that denote the amount of ordering within the molecule. The values for the order parameters of all carbon-carbon bonds of an alkyl chain can be calculated by employing a bond order parameter propagation rule combined with the order parameters of the carbon-hydrogen and hydrogen-hydrogen internuclear vectors of each moiety and only one carbon-carbon bond order parameter. There is enough information contained in the three internuclear vector order parameters of an alkyl chain of a uniaxial liquid crystal to define the entire set of order parameter tensors for the molecule via a second rank tensor transformation of the order parameter tensor for each moiety. These internuclear vector order parameters are obtainable from nuclear magnetic resonance dipolar and quadrupolar measurements. Diagonalization of the order parameter tensor for each moiety transforms the tensor into principal form. The principal axes are the "true" measure of the amount of orientational order within each moiety of the molecule. In addition, the most rigid moiety will determine the molecular orientational order of the molecule. Two presentations were given reporting the preliminary results of this investigation.

Synthesis of Amphiphilic Azo Dyes for Second Harmonic Generation

Researcher: Midshipmen 1/C Mark W. Peters and John-Paul H. Rue
Adviser: Assistant Professor William T. Lavell

The goal of this project was to prepare a dipolar, rigid-rod, amphiphilic organic molecule suitable for partitioning at the interfacial region of a diblock copolymer. Previous work resulted in the synthesis of dipolar, rigid-rod, amphiphilic organic molecules suitable for partitioning at aqueous/non-aqueous interfaces.

Dioctadecylamine was reacted with 4-fluoronitrobenzene in refluxing acetonitrile to form 4-nitro-N,N-dioctadecylaniline; reduction of the nitro group with tin metal in HCl, and diazotisation/hypophosphorous acid deamination resulted in the synthesis of N,N-dioctadecylaniline. Coupling of the aniline with freshly prepared p-benzenediazonium carboxylic acid tetrafluoroborate, in acetic acid solution, yielded a dipolar azo acid. This acid was coupled with amino-terminated polystyrene (molecular weight 4000) in 50% yield using dicyclohexylcarbodiimide in methylene chloride. Separation of the ester from unreacted aminopolystyrene is still under investigation and will likely be accomplished by HPLC.

Investigation of a Pyridine Ring Opening

Researcher: Midshipman 2/C Jayson W. Schwantes, USN
Adviser: Assistant Professor Debra K. Heckendorn

The research undertaken primarily focused on the synthesis and subsequent reactions of methyl 3-[1-(2-pyridyl)ethylidene]methyl-hydrazinecarbodithioate. This compound was prepared to investigate its chemotherapeutic properties. Subsequent investigations of its chemical reactivity showed an unusual ring-opening reaction wherein the pyridine ring was cleaved by nucleophiles.

An investigation into the ring-opening reactions of this acetyl pyridine derivative was undertaken. Initial investigations looked at the preparation of this derivative. The instability of this compound toward nucleophiles make its preparation and isolation difficult. Most reaction conditions attempted led to subsequent reactions of the product. The use of conditions which avoided the use of nucleophiles allowed for the conversion of acetyl pyridine into the carbodithioate in excellent yield. Examination of the reactions of the dithioate with nucleophiles under various conditions was also undertaken. Results of these reactions gave further insight into the reactivity of the unstable dithioate formed. It was susceptible to attack by nucleophiles containing active methylene groups, such as malononitrile. However, not all such nucleophiles will react. Steric demands of the nucleophile are also important in determining reactivity. The sensitivity of the reaction to steric demands was also seen in reactions of the dithioate with amine nucleophiles. Again, unhindered nucleophiles did react while those with bulkier substituents were inert.

The investigation into the chemistry of this interesting dithioate is continuing. Further examination of the use of nucleophiles and various acidic and basic catalysts should give insight into the mechanism and scope of the interesting aromatic ring cleavage.

Synthesis and Characterization of Metal Dithiocroconate Complexes

Researcher: Midshipman 1/C Richard J. Slakes, USN
Adviser: Assistant Professor William B. Heuer

Metal dithiocroconate complexes are currently the subject of investigation owing to their possible application in the preparation of molecular solids with novel physical properties. The focus of this project was the preparation of manganese, vanadium, and molybdenum dithiocroconate complexes. Direct reaction of Mn(II) salts with potassium dithiocroconate in several solvents failed to yield crystalline products. Subsequent UV-VIS analysis of the reaction mixtures showed no evidence for complexation of Mn(II) by dithiocroconate. Since other similar dithiolene ligands readily form complexes with Mn(II), this result suggests that the strongly electron withdrawing character and/or a larger chelate "bite" of the dithiocroconate ligand disfavors complexation in this case. Reaction of potassium dithiocroconate with V(III) salts likewise failed to yield tractable crystalline products, while reaction with Mo(V) apparently led to oxidative degradation of the ligand itself. Preliminary results of the reaction between Mo(II) and potassium dithiocroconate appear to be more promising, but a pure product has not yet been obtained from this reaction.

Nuclear Structure in Organismal Development

Researcher: Midshipman 1/C Geoffrey A. Wright, USN
Adviser: Assistant Professor John W. Bodnar

The role of asymmetric nuclear divisions in organismal development was studied both experimentally and theoretically.

Methods were developed to study asymmetry in the division of cells grown in tissue culture. Equipment was obtained and protocols examined to record growth of human cancer cells by time lapse video photography to determine whether those cells are totipotent in tissue culture (i.e., all cells can divide) or contain stem cell populations (i.e., divide asymmetrically from only a few cells in the population). These protocols should serve as a basis for further studies into the cellular mechanisms for differentiation into the many cell types in a growing organism.

Preliminary fate maps of cell lineages in the nematode C. elegans were compiled from current literature to serve as a basis for computer models and simulations on the division of cells into the various cell types in a growing embryo. These should provide insight into mechanisms for development by comparison with similar fate maps and simulations we have recently compiled for growth of the fruit fly Drosophila embryo.

Publications

BODNAR, John W., Assistant Professor, "Telephone Book of Life," *Nature*, 361 (18 February 1993), 580.

There are many different kinds of information systems such as libraries, computers, telephone books, and the human genome. Insights into the structure and function of the cell nucleus and the human genome can be obtained by assuming it operates by rules for information access similar to a telephone book or other information systems.

BODNAR, John W., Captain, USNR-R, "The Military Technical Revolution - From Hardware to Information," *Naval War College Review*, 46 (Summer 1993), 7-21.

CHEMISTRY

The conduct of war changed dramatically between World War II and Operation Desert Storm. The major differences resulted from a revolution in military technology. An analysis of this "military technical revolution" indicates that these changes have had three distinct "revolutions"--in engineering, sensors, and information. Specific changes caused by each type of revolution are traced from World War II through Desert Storm to project changes in force structures over the next decade.

CAMPBELL, Mark L., Assistant Professor, co-author, "Electronic Quenching of the B $^2\Sigma^+$ State of AlO," *Chemical Physics Letters*, 194 (June 1992), 187-190.

Electronic quenching rate constants for the B $^2\Sigma^+$ state of AlO were determined using a pulsed-laser photolysis laser-induced fluorescence technique by examining fluorescence decay rates in the presence of seven atomic and molecular collision partners. The two polar molecules CO and NO were found to have rate constants of 4.8×10^{-12} and 1.8×10^{-10} cm^{3}s^{-1}, respectively. The nonpolar gases He, H$_2$, N$_2$ CO$_2$ and Xe were found to be poor quenchers with a bimolecular quenching rate constant having an upper bound of 1×10^{-13} cm^{3}s^{-1} for He, H$_2$, N$_2$ and Xe and 1×10^{-12} for CO$_2$.

CAMPBELL, Mark L., Assistant Professor, "Comment on Kinetic Study of the Mg(^{1}S) Reaction with Cl$_2$($^1\Sigma_g^+$) in the Temperature Range from 300 to 900 K," *Journal of Physical Chemistry*, 97 (April 1993), 3922-3923.

The rate constant for the reaction Ti(^{3}F$_2$) + Cl$_2$ has been determined at 296 K, 383 K and 495 K using a laser photolysis/laser-induced fluorescence technique. Ground state titanium atoms were produced by the photolysis of the TiCl$_4$ precursor using the 248 nm output a KrF excimer laser. The temporal profile of the titanium atoms was determined by measuring the titanium atom laser induced florescence signal as a function of laser delay. Pseudo-first order rate constants were determined as a function of chlorine gas pressure from which the bimolecular rate constant was determined. The bimolecular rate constant is independent of temperature and has a value of $(4.1 \pm 0.7) \times 10^{-10}$ cm^{3}s^{-1}. The rate constant corresponds to almost twice the hard-sphere collision rate indicating a harpoon-type electron transfer mechanism.

CHEEK, Graham T., Associate Professor, "Electrochemical Reduction of Aromatic Ketones in a Room-Temperature Molten Salt," *Proceedings* of the Electrochemical Society, PV 92-16 (1992), 426-437.

The electrochemical reduction of the aromatic ketones benzophenone and fluorenone has been studied in the aluminum chloride : 1-ethyl-3-methylimidazolium chloride molten salt. As in the case of other carbonyl systems, the ketone oxygen is complexed by aluminum chloride in the acidic melt, causing a marked change in electrochemical behavior as the Lewis acidity of the melt is changed. Preparative electrolyses reveal that fluorenone reduction in the basic melt produces the pinacol (one-electron, dimeric) product, whereas reduction of benzophenone forms the alcohol (two-electron, monomeric) product. The formation of a smaller amount of tetraphenyloxirane during benzophenone reduction shows that abstraction of oxide by the melt is a significant reaction pathway under these conditions. Some evidence for this reaction has also been found in the fluorenone systems, although in more acidic melts.

D'ALESANDRO, Michele M., Lieutenant Commander, USN, co-author, "Polar T3 Syndrome: Meaning for Midlatitude Residents," *Antarctic Journal of the United States*, 26(5), (1991), 239-240.

The effects of thyroid hormones and changes in their regulatory mechanisms were studied and reported on two populations of subjects undergoing significant seasonal exposure, but not living in Antarctica. Furthermore, to clarify the time course and molecular mechanisms of the polar T3 syndrome, subjects were studied both before their deployment to McMurdo, Antarctica, and monthly thereafter for 40 weeks while they were in McMurdo during 1989-1990. The nuclear T3 binding sites on circulating white blood cells were characterized during these studies.

D'ALESANDRO, Michele M., Lieutenant Commander, USN, co-author, "Indoor Temperature Variations in McMurdo, Antarctica," *Antarctic Journal of the United States*, 26(5), (1991), 237-238.

A longitudinal study of meteorological and indoor temperature fluctuations, with emphasis on temperature gradients, experienced from head to foot during the 1989-1990 season was performed.

CHEMISTRY

The objective was to define more accurately the actual living conditions and extent of cold exposure experienced by winter-over personnel in McMurdo. The McMurdo, Antarctica research station consists of approximately 100 structures that accommodate as many as 1,200 people during the austral summer (October to January) and a small contingent of military and civilian personnel during winter-over operations (February to October).

D'ALESANDRO, Michele M., Lieutenant Commander, USN, co-author, "Multiple Cold Air Exposures Change Oral Triiodothyronine (T₃) Kinetics in Normal Men," *American Journal of Physiology: Endocrinology and Metabolism*, 263(26), (1992), E385-393.

The influence of cold exposure on triiodothyronine (T_3) kinetics was studied in 16 men before, during (biweekly), and after 80 (10 per week) cold (4°C) air exposures. Serum values before and up to 24 hours after a pharmacological oral (o) dose of T_3[76.8 nmol (50 µg)] were used to calculate noncompartmental kinetic parameters. To assess the role of thyroxine (T_4) and thyrotropin (TSH), a replacement dose of T_3 [46.0 nmol/day (30 µg)] was administered to eight men (+T_3 group) and placebo to eight others (-T_3 group) for the 2-month study. There was no group effect of T_3 treatment (+T_3) on total volume of distribution (TVd_o), metabolic clearance rate (MCR_o), or disposal rate (DR_o). TVd_o was not changed over the study. Cold exposure increased MCR_o by 5.4± 2.0 1·day⁻¹·m⁻². DR_o increased with cold exposure by 10.2 ± 4.4 nmol·day⁻¹·m⁻². Although serum TSH, total T_4, and free T_4 decreased by ~50% in the +T_3 group, the changes in MCR_o and DR_o with cold were not different from those in -T_3. There appear to be changes in human T_3 kinetics with brief repeated exposures to cold air and increases in MCR_o and DR_o do not appear to be dependent on TSH or T_4.

D'ALESANDRO, Michele M., Lieutenant Commander, USN, co-author, "Human Cold Air Habituation is Independent of Thyroxine and Thyrotropin," *Journal of Applied Physiology*, 72(6), (1992), 2134-2139.

Thyroxine (T_4) is required in species possessing brown adipose tissue (BAT) for the maintenance of cold tolerance and adaptation. In humans, who possess negligible quantities of BAT, the importance of T_4 has not been demonstrated. The effects of decreased serum T_4 and thyrotropin (TSH) on

human cold habituation after repeated cold air exposures were analyzed. Eight men (T3+) received a single daily dose of triiodothyronine (T_3; 30 µg/day), and another eight men (T3) received a placebo. All 16 normal leuthyroid men underwent a standardized cold air test (SCAT) under basal conditions in January and again in March after eighty 30-minute 4.4°C air exposures (10 per week). Measurements of basal metabolic rate (BMR), O_2 consumption (Vo_2), mean arterial pressure (MAP), plasma norepinephrine (NE), serum TSH, free and total T_4, and free and total T_3 were repeated before and after 8 weeks of exposure TSH, free T_4, and total T_4 were 50% lower for T3+ than for T3 subjects. Total and free T_3 were not different between groups. BMR was unchanged after habituation, whereas the cold-stimulated Vo_2, MAP, and NE were significantly reduced for all subjects in March. The relationship between Vo_2 and NE (r^2 = 0.44, P < 0.001) during the initial SCAT was unchanged with habituation. These results suggest that human cold habituation is independent of major changes in circulating T_4 and TSH.

ELERT, Mark L., Professor, co-author, "Simulations of Chemically-Sustained Shock Fronts in a Model Energetic Material," *Shock Compression of Condensed Matter* - 1991, eds. S. C. Schmidt, R. D. Dick, J. W. Forbes, D. G. Tasker. Amsterdam, The Netherlands: Elsevier Science Publishers B.V., (1992), 123-126.

Tersoff-like potentials together with molecular dynamics calculations are used to simulate the detonation of an energetic two-dimensional semi-infinite molecular solid. The resulting shock front produced in this system exhibits four separate regions whose distinct interfaces between the regions move at constant and different velocities. The properties of the resulting shock front are independent of the initiation conditions. The model predicts a critical minimum impact velocity for a chemically-sustained shock front.

ELERT, Mark L., Professor, co-author, "Molecular Dynamics Simulations of Shock-Induced Chemistry: Application to Chemically Sustained Shock Waves," *Microscopic Simulations of Complex Hydrodynamic Phenomena*, eds. M. Mareschal and B. L. Holian, New York, New York: Plenum Press (1992), 111-123.

Detonations travel through solid explosives as shock waves accompanied by rapid rises in temperature

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and pressure that cause the exothermic chemical reactions which sustain them. Because of the short time and length scales involved, molecular dynamics simulations can potentially probe their initiation and subsequent interplay with chemistry at the shock front. Such simulations may also clarify how this discrete shock induced chemistry relates to those properties of detonation that are understood by continuum (hydrodynamic) theories. To be at all convincing, however, these simulations require a model that is sufficiently simple to treat condensed phase systems containing several thousand atoms while incorporating traditional chemical concepts such as concerted reactions and energy release via the formation of product molecules. Such a model is presented here for a two-dimensional diatomic energetic molecular solid using empirical bond order potentials. Simulations using this model possess characteristics expected of a detonation while displaying such rich behavior as shock wave splitting caused by the loss of molecular identity at high pressures.

ELERT, Mark L., Professor, co-author, "Description a l'echelle moleculaire des ondes de choc soutenes chimiquement," ("Molecular Description of Chemically Sustained Shock Waves") *Revue Scientifique et Technique de la Défense*, 16 (1992), 157-160.

A many-body potential energy expression is presented which makes possible efficient and accurate molecular dynamics simulations of condensed-phase systems at high energy, including dissociation and recombination of diatomic species. The model is applied to the shock-induced initiation of detonation in a two-dimensional system. Depending on the details of the potential function employed, a rich variety of shock-induced chemistry can be observed. Conditions leading to the formation of multiple shock waves in the detonating material are examined in detail.

FERRANTE, Robert F., Associate Professor, co-author, "Catalytic Crystallization of Ices by Small Silicate Smokes at Temperatures Less Than 20 K," *Proceedings* of the Lunar and Planetary Society Conference, 24 (1993), 1007-1008.

Samples of methanol and water ices condensed from the vapor onto aluminum substrates at low temperatures (below 80 K) form amorphous ices; annealing at temperatures in excess of 140-155 K, or particle irradiation, is usually required to convert such amorphous samples to crystalline ices. However, we have found that the ices condense directly in crystalline form at T < 20 K if the Al substrate is first coated with a thin (0.1-0.5 mm) layer of amorphous silicate smoke. The silicate surface thus exposed to the vapor has grain sizes in the range 20-40 nm. Smokes are produced by the vaporization of SiO solid at T > 1500 K, followed by vapor phase nucleation and growth in a 100 torr hydrogen atmosphere. After low temperature deposition on the coated substrates, the phase of the condensate is examined by FT-IR spectroscopy in the mid- or far-IR ranges. It is believed that the catalytic activity is a result of the energy liberated from weak bonding of water or methanol molecules to oxygen defect sites at the ice/silicate interface. The high defect density, and very high surface/volume ratio of the amorphous silicate coatings support this interpretation. Trapping of gases by the production of clathrates in the outer solar nebula, through the annealing of amorphous water ice mixed with volatiles, has been suggested as a means of explaining the continued presence of a volatile component of comets and icy satellites of the outer planets, despite their extreme thermal processing. If amorphous ice does not form on cold silicate grains in these regions, that hypothesis may need to be re-examined.

FITZGERALD, Jeffrey P., Assistant Professor, co-author, "Synthesis and Characterization of 'Picnic-Basket' Porphyrins with a Substituent in the Interior of the Pocket," *Chemical and Pharmaceutical Bulletin*, 40 (December 1992), 3157-3162.

"Picnic-basket" porphyrins of a new type, that having a substituent in the interior of the pocket, were synthesized to study stabilization of the bound oxygen in hemoprotein models. Though these Co(II) porphyrins have enormous equilibrium constants for the formation of base adducts, hydrogen-bonding interactions with coordinated dioxygen are not as effective for stabilizing the metal-dioxygen bond as had been expected. The results suggest that doming of the porphyrin plane plays an important role in the binding of dioxygen.

HEUER, William B., Assistant Professor, co-author, "Preparation and Characterization of (Tetrabenzoporphyrinato)cobalt(II) Iodide, a Ring Oxidized Molecular Conductor," *Inorganic Chemistry*, 31 (1992), 4517-4523.

Oxidation of (tetrabenzoporphyrinato)cobalt(II),

Co(tbp), with iodine affords Co(tbp)I. The structure comprises metal-over-metal columnar stacks of partially (one-third) oxidized Co(tbp) groups surrounded by chains of I_3^- ions. In contrast to (phthalocyaninato)cobalt(II) iodide, Co(pc)I, which shows metal oxidation and is a metal-spine conductor, conductivity and thermoelectric power measurements on Co(tbp)I show that the oxidation occurs at the macrocycle; the charge carriers are holes in the five-sixths-filled band comprising overlapping orbitals from adjacent tbp rings. Reflectance spectroscopy measurements on single crystals are consistent with this view of the electronic structure. Results of magnetic susceptibility and electron spin resonance studies indicate that the localized, metal-based spins of the Co(tbp) units are strongly anti-ferromagnetically coupled within the 1-D stacks. It is unclear at present whether the coupling mechanism involves direct metal-metal interactions or indirect interactions mediated by charge carriers in the ligand-based conduction band, as found in the analogous compound Cu(pc)I.

KOUBEK, Edward, Professor, "The Analysis of Sulfur in Coal," *Journal of Chemical Education*, 69 (1992), A146-A148.

Ion chromatography is used in this analysis to determine the sulfur content in coal. The sulfur is converted into soluble sulfate by heating the coal overnight with a mixture of MgO and Na_2CO_3 at 800°C. The resulting sulfate is dissolved in a known volume of solution and determined via ion chromatography.

KOUBEK, Edward, Professor, "Demonstration of the Common Ion Effect," *Journal of Chemical Education*, 70 (1993), 155.

Chemistry texts often state that the solubility of an ionic compound will decrease whenever an ion in common is added to the solution. Although this statement is basically true, there are times when it is not, such as when complex ion formation can occur. At other times, it may appear not to be true for other reasons as illustrated in this article.

LOMAX, Joseph F., Assistant Professor, "Conducting Midshipmen," *Journal of Chemical Education*, 69, (1992), 794-795.

An analogy using student movement as an integral part of the discovery of the concepts of charge movement in solids is presented. The solid is recognized as one of the primary states of matter, but it is often treated as an outcast in the General Chemistry courses taught in high school and college. With this analogy, a seemingly difficult set of concepts can be brought to life and learned in a quick, entertaining way.

PEARSON, Wayne H., Assistant Professor, and Joseph F. LOMAX, Associate Professor, "X-ray Crystal Diffraction Study of Zr,Na-β"-Aluminas," Materials Research Society Symposium *Proceedings*, 293 (1993), 315-320.

The reaction of crystalline lithium-stabilized Na-β"-Alumina with zirconium(IV) chloride at 400°C for 303h has caused sodium ions to exchange with zirconium ions. An X-ray crystal diffraction study of both the parent lithium stabilized Na-β"-alumina (1) and the partially zirconium exchanged product (2) have been made at 147 K. Crystal data for 1: rhombohedral, *R3m*, a = 5.6037 (3), c = 33.6210 (86), *V* = 914.31 (24). Crystal data for 2: rhombohedral, *R3m*, a = 5.5994 (5), c = 33.7711(51), *V* = 916.96 (16). Zirconiums in 2 reside, predominately, in the Beevers-Ross type site.

POMEROY, Robert S., Assistant Professor, "The Future of Intelligent Spectrometers in Speciation by Atomic Emission Spectrometry," *Trace Metal Analysis and Speciation*, ed. I. Krull, Amsterdam, The Netherlands: Elsevier Science Publishers B. V., Chapter 4, (1991), 75-98.

Analytical chemists are interested in qualitative analysis, quantitative analysis, and speciation. Plasma spectroscopic techniques, while far from being such a conceptually ideal analyzer, can contribute to our knowledge of elemental constituents and their quantization; however, by themselves, these techniques do not provide insight into speciation. Chromatography provides a separation in time of closely related chemical species, but many of the detection schemes used with chromatography offer limited information. The power of combining chromatographic separation techniques with element specific detection can help provide great insights into speciation.

Charge transfer device array detectors have many characteristics that make them particularly well suited for this type of application. Spectroscopic systems employing charge injection device (CID) technology should benefit from the tremendous

flexibility in wavelength selection afforded by a CID/AES system, as well as the sensitivity offered by the CID. The CID is easily capable of following element specific transient signals which require recording on sub-second time intervals, allowing the system to be applicable in all areas of chromatography. These systems also lend themselves nicely to automation and expert system development as all of the spectroscopic information is made available to the analyst and the computer.

POMEROY, Robert S., Assistant Professor, "Analytical Luminescence Spectroscopy," *Charge Transfer Devices in Chemistry*, ed. J. V. Sweedler and K. L. Ratzlaff. New York: VCH Publishers, Chapter 8, (1993), 801-853.

Recent technological advances in solid state imaging detectors offer the analytical chemist new alternatives for the detection of luminescence emission. Charge Transfer Device (CTD) detectors are sensitive multichannel detectors with large dynamic ranges. One particular class of CTD, the charge-coupled device (CCD) is particularly well suited to low light level spectroscopies due to their high quantum efficiency and low noise characteristics.

This chapter is divided into four sections. The first section provides background material on luminescence processes so as to introduce the operational necessities and factors that influence chemical analysis and the measured luminescence. The second section addresses the instrumental needs and present instrumentation. The third section introduces CTD detectors and their capabilities for low light level spectroscopy. The final section presents sample applications of CTD systems to analytical luminescence spectroscopy. The applications are broken into three categories: total luminescence analysis, luminescence detection coupled to separation techniques, and luminescence imaging.

POMEROY, Robert S., Assistant Professor, "Atomic Emission Spectroscopy," *Charge Transfer Devices in Chemistry*, ed. J. V. Sweedler and K. L. Ratzlaff. New York: VCH Publishers, Chapter 10, (1993), 1001-1049.

This chapter offers basic background information on atomic emission spectroscopy so as to provide the framework for how and why Charge Transfer Device (CTD) detectors are incorporated into spectroscopic systems. Brief descriptions of the spectroscopic systems developed to date are presented. The discussion then addresses the use CTD detectors to atomic spectroscopy and the application of these spectroscopic systems to various modes of elemental analysis. The principal advantage of these systems is their complete acquisition of all the spectroscopic data over a large spectral region with performance characteristics equaling and surpassing the commercially available conventional spectroscopic systems. Automation is currently a central theme in the development of new analytical instrumentation. Active control and "intelligent" instruments are the focus of the future. The rapid developments in computer technology combined with the multichannel data acquisition of CTD based spectroscopic systems are changing the face of atomic emission spectroscopy.

POMEROY, Robert S., Assistant Professor, "Spectroscopic Applications of Charge Transfer Devices," *Spectroscopy*, 7(8) (November 1992), 28-35.

Analytical spectroscopic techniques have long been used to qualitatively and quantitatively investigate sample composition. Traditional detectors have limitations that generally impair attempts to acquire or use all of the information a technique might provide. Phototubes, photomultipliers, photodiodes, photographic emulsions, and photovoltaic cells suffer one or more problems associated with bulkiness, nonlinearities, limited dynamic ranges, limited number of resolution elements, poor quantum efficiencies, or in the case of photographic emulsions, a tremendous time and facilities overhead associated with development and reading. Charge-Coupled and Charge Injection devices (CCDs and CIDs) have overcome most of these shortcomings while at the same time providing large numbers of detector elements in a compact format that lends them to a variety of scientific imaging applications. Their high quantum efficiencies over a broad wavelength region, combined with low read-noise characteristics, provide a sensitive and versatile detector.

POMEROY, Robert S., Assistant Professor, "Imaging Applications for Chemical Analysis Utilizing Charge-Coupled Device Array Detectors," *Trends in Analytical Chemistry*, 12(7) (August 1993), 202-208.

Charge-Coupled Device (CCD) array detectors have made an enormous impact on the field of analytical

chemistry and are revolutionizing both spatial and spectroscopic chemical analysis. The recent chemical literature reveals a wide variety of analytical techniques and applications for which the uses of CCDs have been investigated.

The acceptance of CCDs for spectroscopic analysis has been slower than for direct imaging analysis because of difficulties in designing optical systems which match the physically small area of these devices, which are commonly about the size of a postage stamp. Many difficulties have been overcome and a number of companies are now supplying spectrographs specifically designed to take advantage of these detectors.

This article focuses on the use of scientifically operated CCD area array detectors for spectroscopic and spatial imaging applications related to analytical chemistry. It is not the intention of this review to address all possible applications currently under investigation. Rather, the goal is to address several of those techniques which best illustrate the capabilities of the scientifically operated CCD detector as a valuable analytical tool. A significant portion of this article also addresses current trends and possible future directions of this technology.

WAITE, Boyd A., Associate Professor, and Joel D. STEWART, Ensign, USN, "An Idealized Dynamical Model of Simple Diffusional Interactions Between Macromolecules and Between Macromolecules and Surfaces," *Mathematical Biosciences*, 114 (1993), 173-213. A model for hard-sphere, nonelectrostatic diffusional interactions between macromolecules and between macromolecules and surfaces is presented. Quantities such as average free path and impact frequency are derived, being validated by full three-dimensional simulations of large numbers of random flights. A method for obtaining the total collision rate is developed based on absorption boundary conditions applied to the time-independent diffusion equation, multiplied by the probable number of subsequent encounters. A distribution function is obtained that describes both the spatial and temporal impact profiles of diffusing molecules with surfaces as well as the detailed nature of individual encounters. Conclusions are that the interaction of diffusing macromolecules with surfaces is an extremely efficient process; trajectories are typified by clusters of relatively closely spaced encounters separated by relatively long excursions prior to reimpact. Results should be applicable to the development of kinetic models for describing such complex phenomena as ligand binding to receptors on cell surfaces.

Presentations

BROWN, James E., Midshipman 1/C, USN, Joyce E. SHADE, Associate Professor and Wayne H. PEARSON, Assistant Professor, "Synthesis and Characterization of Organometallic Compounds of Iron and Ruthenium," Semon Undergraduate Research Symposium, Kent State University, Kent, Ohio, 11-13 April 1993.

BROWN, James E., Midshipman 1/C, USN, Julie A. HANSEN, Ensign, USN, Joyce E. SHADE, Associate Professor, and Wayne H. PEARSON, Assistant Professor, "Photochemisty of [CpFe(CO)]$_2$-u-DPPX, where DPPX = DPPM, DPPE or DPPP. An Unexpected Radical Reaction Route," 44th Southeastern-26th Middle Atlantic Joint Regional Meeting of the American Chemical Society, Arlington, Virginia, 6-9 December 1962.

CHEEK, Graham T., Associate Professor,

"Electrochemical Reduction of Aromatic Ketones in a Room-Temperature Molten Salt," 204th National Meeting of the American Chemical Society, Washington, DC, 26 August 1992.

CHEEK, Graham T., Associate Professor, "Electrochemical Reduction of Benzophenone in a Room-Temperature Molten Salt," 44th Southeastern-26th Middle Atlantic Joint Regional Meeting of the American Chemical Society, Arlington, Virginia, 7 December 1992.

CHEEK, Graham T., Associate Professor, "Quartz Crystal Microbalance Study of Mercury Deposition on Platinum," Gordon Conference on Electrochemistry, Ventura, California, 20 January 1993.

CHEEK, Graham T., Associate Professor,

"Electrochemical Studies of Indigoid Systems," 183rd Electrochemical Society Meeting, Honolulu, Hawaii, 18 May 1993.

ELERT, Mark L., Professor, "Molecular Dynamics Simulations of Chemically-Sustained Shock Waves," American Physical Society National Meeting, Seattle, Washington, 26 March 1993.

FERRANTE, Robert F., Associate Professor, "IR Spectroscopy of Cometary Ice Analogs," NASA/Goddard Space Flight Center, Greenbelt, Maryland, 31 July 1992.

FERRANTE, Robert F., Associate Professor, "Spectroscopy at Low Temperatures: From Combustion to Comets," Susquehanna Valley Section Meeting of the American Chemical Society, Scranton, Pennsylvania, 9 September 1992.

FERRANTE, Robert F., Associate Professor, co-author, "Catalytic Crystallization of Ices by Small Silicate Smokes at Temperatures Less Than 20 K," 24th Lunar and Planetary Society Conference, Houston, Texas, 17 March 1993.

HANSEN, Julie A., Ensign, USN, Joyce E. SHADE, Associate Professor, and Wayne H. PEARSON, Assistant Professor, "Photochemistry of $[CpFe(CO)]_2$-u-DPPX, where DPPX = DPPM, DPPE or DPPP. An Unexpected Radical Reaction Route," 204th National Meeting of the American Chemical Society, Washington, DC, 23-28 August 1992.

HANSEN, Julie A., Ensign, USN, Joyce E. SHADE, Associate Professor, and Wayne H. PEARSON, Assistant Professor, "Photochemistry of $\{CpFe(CO)]_2$-u-DPPX, where DPPX = DPPM, DPPE or DPPP. An Unexpected Radical Reaction Route," XVth International Conference on Organometallic Chemistry, Warsaw, Poland, 9-14 August 1992.

HECKENDORN, Debra K., "Applications of Molecular Mechanics to Transition State Modeling for an Intramolecular Cyclization," 204th National Meeting of the American Chemical Society, Washington, DC, 27 August 1992.

LOMAX, Joseph F., Assistant Professor, "Kinetic Classroom: Acid/Base and Redox Demonstrations with Student Movement," Joint 44th Southeastern-26th Middle Atlantic Regional Meeting of the American Chemical Society, 19 December 1992.

LOMAX, Joseph F., Assistant Professor, Nancy CARNEY, Staff, Wayne H. PEARSON, Assistant Professor, Mary C. WINTERSGILL, Professor, (Physics) and John J. FONTANELLA, Professor, (Physics) "Zirconium/Sodium-β"-Alumina: Synthesis, Structure and Electronic Properties of β"-Alumina with a New Probe Ion." Joseph F. Lomax, Material Research Society, 19th Fall Meeting, Boston, Massachusetts, 19 December 1992.

LOMAX, Joseph F., Assistant Professor, Katie M. PATRICK, Midshipman 1/C, USN, Wayne H. PEARSON, Assistant Professor, Mary C. WINTERSGILL, Professor, (Physics) and John J. FONTANELLA, Professor, (Physics) Group IV Ion Exchange Products of β"-Alumina: Synthesis and Characterization." 204th National Meeting of the American Chemical Society, Washington, DC, 19 August 1992.

POMEROY, Robert S., Assistant Professor, "The Application of Charge-Coupled Device Detectors to the Spectrophotometric Determination of pH," Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy, Atlanta, Georgia, 8-12 March 1993.

POMEROY, Robert S., Assistant Professor, "The Thermodynamics of the Dissociation of HEPES in Synthetic Sea Water," Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy, Atlanta, Georgia, 8-12 March 1993.

POMEROY, Robert S., Assistant Professor, "The Spectrophotometric Determination of pH Using a Diode Array Spectrophotometer," Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy, Atlanta, Georgia, 8-12 March 1993.

POMEROY, Robert S., Assistant Professor, "Potential Application of State-of-the-art Solid State Optical Spectroscopic Components to the Chemical Analysis of Sea Water," Florida International University, Miami, Florida, 12 March 1993.

SIATKOWSKI, Ronald E., Assistant Professor, "Molecular Orientational Order of a Nematic Liquid Crystal," Department of Chemistry, Western Connecticut State University, Danbury, Connecticut, 7 May 1993.

SIATKOWSKI, Ronald E., Assistant Professor,

"Molecular Orientational Order of a Nematic Liquid Crystal," Department of Chemistry, Buffalo State College, Buffalo, New York, 11 May 1993.

SLATKOWSKI, Ronald E., Assistant Professor, "Trilisate Project, Part I: Statement of Problem and Proposed Investigation," Purdue Frederick Company, Corporate Headquarters, Norwalk, Connecticut, 8 July 1992.

SLATKOWSKI, Ronald E., Assistant Professor, "Trilisate Project, Part II: Results of Investigation and Conclusions," Purdue Frederick Laboratories, Totowa, New Jersey, 18 August 1992.

Computer Science

Commander Leroy G. Williams, USN
Chair

During the 1992-1993 academic year, the Computer Science Department continued to conduct important research and spread the Academy's name through publishing. The department encourages its faculty to seek summer support through outside funding. Last summer, the Naval Research Laboratory funded three faculty members. Other members were funded by the Defense Mapping Agency, and the Naval Academy Research Committee (NARC).

The Department received a grant from the Director of Defense Information (DDI), Department of Defense, for research and curriculum development involved with the new software programming language, Ada. This grant was supplemented with funding from the Ada Joint Program Office (AJPO).

Student research continued to prosper. Dr. Andrew Phillips worked with Midshipman 2/C Vann Walke in developing a Trident Scholar Proposal. This proposal, entitled "Computational Solutions to the Protein Folding Problem" was accepted for study during the 1993-1994 Academic Year. Commander Charles Floyd monitored an independent research project for Midshipman 1/C Todd Gagnon. The result of that project, entitled "Design and Development of Experiments in Robotics," will serve as the foundation for laboratory exercises for the department's new Robotics course.

Considering the small number of civilian faculty, the Computer Science Department had an extremely productive year. Overall, there were eighteen publications and sixteen presentations.

Sponsored Research

Fractal Data Compressions

Researcher: Professor Frank L. K. Chi
Sponsor: Defense Mapping Agency

The image compression technique proposed by Barnsley and his colleagues is revolutionary in that it offers a very high compression ratio. The foundation of their data compression method is the use of iterated file systems (IFS). An image on the screen can be described as a set of few numbers in IFS, instead of the usual description in terms of hundreds of pixel coordinates. The original IFS method provides no definitive, realistic rendering techniques for preserving the color of the images. The research project looks into ways to incorporate a definitive coloring scheme into the image compression method.

Highly Parallel Case-Based Reasoning

Researcher: Professor Patrick R. Harrison
Sponsor: Naval Research Laboratory

This program of research in Case-Based Reasoning has three objectives: (1) Develop a strong theoretical basis for the design and implementation of a highly parallel, case-based reasoning and

planning tool; (2) Implement and test tool components; and (3) Integrate tool components into a development environment. Currently, a theoretical model has been developed. A sensor classification system based on case data from Naval Air Warfare Center (NAWC), Warminster has been implemented. Tool components are under development.

The Effects of Stress on Communication Behavior in the Context of a Team Decision Task

Researcher: Associate Professor Kay G. Schulze
Sponsor: Naval Research Laboratory

Communications are a crucial aspect of decision making in a variety of contexts, including military decision making. Since the human computer interface can be viewed as a mechanism for the exchange of information between the user and the computer with the goal of solving a problem, the researcher began the research to model the causes of breakdowns in the decision making process in a verbal intensive environment. Manipulating the communications network by varying the problem to be solved and adding environmental pressures that stress the functioning of the network, will provide a model in which to discover the underlying factors necessary to provide computer-based systems that support effective and efficient human information processing and decision making in a verbal intensive environment.

Independent Research

Ada Curriculum Development for Software Engineering with Ada

Researcher: Associate Professor Eun K. Park

The goal of this research is to redesign the existing Software Engineering course to incorporate Ada language in the course. This new revised course will be Ada based Software Engineering and will be a project based team oriented that will present the software development lifecycle and methodologies for dealing with each phase. At the completion of the course, students should be able to develop software in Ada that meets the software engineering principles of abstraction, information hiding, modularity, localization, uniformity, completeness, and confirmability.

Computational Solutions to the Protein Folding Problem

Researcher: Assistant Professor Andrew T. Phillips

The goal of this research is to develop an efficient algorithm for solving the protein folding problem. The protein folding problem is discussed, and a concave quadratic global minimization approach for solving the problem is described. This approach is based on a quadratic assignment formulation of a discrete approximation to the original problem. The protein folding problem is formulated so that it can be solved by a two stage approach. The problem is first modeled by a discrete approximation on a 3-dimensional lattice. This discrete lattice model can be formulated as a quadratic assignment problem and then transformed into a continuous concave quadratic global minimization problem. The global solution to this concave minimization problem can then be used as

starting point for the second stage--a "relaxed" continuous minimization problem. The result of this second stage should provide a global, or near global, minimum of the potential energy function, and hence a prediction of the native, or folded, state of the protein. This project was supported by the Minnesota Supercomputer Institute.

Computational Methods for Linearly Constrained Concave Global Minimization

Researcher: Assistant Professor Andrew T. Phillips

This research program investigates two parallel algorithms for linearly constrained concave global minimization problems. This project was begun at the Army High Performance Computing Research Center (AHPCRC) in June 1991 and has been progressing since that time. The overall objective of this work is to design and implement a new algorithm which, by taking full advantage of parallel computing capabilities, will efficiently solve linearly constrained concave global minimization problems on the connection Machine CM-2, CM-5, and Cray X-MP supercomputers. Constrained global optimization problems arise in many important areas of science and technology and include scheduling and allocation problems with non-convex objective functions and a variety of computer-aided-design and computational geometry applications.

These kinds of optimization problems may possess many constrained local optima, but an acceptable solution to the problem requires that a global optimum, or a good approximation to it, be obtained. Because of the inherent difficulty of computing the global optimum, the emphasis of this research will be on the design and implementation of an efficient algorithm which obtains an approximate solution to these problems on parallel computers in a reasonable amount of time. Primary interest is placed on the average, rather than worst case, behavior of these algorithms, and the performance analysis of this behavior will require a combination of both theoretical investigation and extensive computational testing. This research was funded by the Minnesota Supercomputer Institute.

Research Course Projects

Design and Development of Experiments in Robotics

Researcher: Midshipman 1/C Todd A. Gagnon, USN
Adviser: Commander Charles A. Floyd, USN

The purpose of this project was to develop laboratory demonstrations and experiments that would reinforce theoretical knowledge pertaining to robots and robotics. Two general areas were investigated: (1) the use of a fixed-base robot arm to study motion and planning, and (2) the use of a mobile platform to study motion control, world knowledge acquisition, and behavior representation. One major task accomplished was the implementation of a library of functions written in the C programming language to provide robotic arm control and sensor inputs. Using this library, users will be able to develop programs that deal with higher level functions without regard to low level details. A second major accomplishment was the construction and testing of a small mobile robot built using LEGO blocks. The robot is controlled by an onboard microprocessor that drives the motors and collects sensor input information. Sensors for both the fixed-base and the mobile platform were developed to provide the programmer with a means of obtaining information about the real world. The majority of this work has been completed, and three sections of a laboratory manual have been completed. The remaining sections deal with computer vision, and will be

developed during the Fall 1993 semester.

Publications

HARRISON, Patrick R., Professor, co-author, "Intelligence Real-Time Sensor Control," *Proceedings* of the Twenty-third Annual Pittsburgh Conference on Modeling and Simulation, (1992), pp. 1071-1080.

This article summarized work on an intelligent control system for the F-14D aircraft. The current version of the system fuses data from radar, IR and other onboard sensors to create a world state that is used by an expert system component in the sensor control loop. The expert systems component called the Advice Generator controls both radar operation and radar modes to optimize target acquisition.

HARRISON, Patrick R., Professor, co-author, "New Developments of a Knowledge-Based Systems (VEG) for Inferring Vegetation Characteristics," *Proceedings* of the IEEE International Geoscience and Remote Sensing Symposium, (1992), pp. 763-765.

This is a summary of current work in an ongoing program of research for NASA. The current paper describes some current additions to the Scientist Workbench called VEG which provides a complex expert system for both analyzing and exploratory work with sensor data from the earth's surface.

HARRISON, Patrick R., Professor, co-author, "An Expert System Shell for Inferring Vegetation Characteristics NASA/Goddard Space Flight Center," JJM Report, 1992, B921020-U-2R00.

This is a technical summary of the actual VEG shell environment. It is a 500+ page detailed summary of the implementation of the Scientist Workbench used by NASA scientist to study sensor data from the surface of the earth.

MYERS, John D., Major, USMC, and Donald M. NEEDHAM, Lieutenant, USN "A Software Engineering Approach to Teaching Ada," Proceedings of the Seventh Annual ASEET Symposium," January 1993, pp 52-59.

Incorporating Ada into undergraduate Computer Science curricula has been hindered on several fronts. Typical problems have been technology-oriented, teaching-oriented, and support-oriented. This paper presents the results of a project-oriented Ada course taught at the Naval Academy in the Fall of 1992. the course was designed to demonstrate software engineering and problem solving techniques and strategies by developing a single, incremental project using Ada.

PARK, Eun K., Associate Professor, "An Expert System for Hybrid-Ethernet Configuration Design," Heuristics: The Journal of Knowledge Engineering, 5, 1, (Spring 1992), 44-58.

Hybrid-Ethernet has been introduced to overcome the shortcomings of Ethernet, e.g., lack of guaranteed private and secure communication, and difficulty in upgrading the performance of the increased system's load. The Hybrid-Ethernet is implemented by adding an additional channel (data links channel) to the conventional Ethernet. Data links may be inserted/removed on a running network between pairs of nodes to accommodate frequent communication, secure/interactive communications based on specific communication characteristics or changes in the application environment. With this architecture, a Local Area Network (LAN) can be installed in the form of Ethernet and may be upgraded and tuned to its application environment by the insertion of node-to-node data links. In this paper, the researcher discusses the development of an expert system that enables one to decide where to insert the data links in order to design the most desirable network configuration. The decision is based on factors such as traffic load, network performance, network capabilities, users' requirement, and others. Machine learning capability can be incorporated into such an expert system to monitor the operation of the system. This capability allows us to reconfigure the design as we learn more about the system in order to optimize throughput and user requirements.

PARK, Eun K., Associate Professor, "A

Comparative Case Study in Object-Oriented Systems Analysis Methodologies," *Proceedings* of International Conference on Design, Analysis and Simulation, March 1993, Washington, DC, pp 195-198.

In this paper, the researcher presents a comparative case study of object-oriented (OO) system analysis methodologies. Three popular methodologies were chosen: Rumbaugh et al, Coad & Yourdon, and Booch. The paper focuses only on the object structure models and their diagram notations. It begins with an ER diagram and compares it with three object models from those methodologies. The researcher has found that Rumbaugh's and Coad & Yourdon's methods are easier to work with than Booch's; the distinction between ER approach and OO approach could become blurred when both are properly extended; and in order for OO approach to be mature the users of OO system analysis and design need more guidelines to produce a complete and consistent analysis output which can be cross-checked among object, dynamic, and functional models.

PARK, Eun K., Associate Professor, "Sparse Hypercube-Like Interconnection Networks," *Proceedings* of ACM Symposium on Applied Computing (SAC 93), 14-16 Febraury 1993, Indianapolis, Indiana, pp 694-700.

It is important to design networks that have many good properties as hypercubes, yet more feasible for hardware implementation. It, also, would be nice to have networks with structures that are similar to hypercubes so that all existing efficient parallel and distributed algorithms can be used. In this paper, we propose a new class of networks call Z-cubes. An n-dimensional Z-cube Q^z_n, where n must be a multiple of 4, consists of 2 inch vertices, as the n-dimensional hypercube Q_n. We show that Q^z_n have many desirable properties. Most importantly, the degree and number of edges of Q^z_n are 1/4 less than the degree and number of edges of n-dimensional hypercube Q_n, and consequently more suitable for VLSI implementation. The diameter of Q^z_n is the same as that of Q_n and the average distance between vertices in Q^z_n is about 1.125 times the average distance between vertices in Q_n. Therefore, the data communication in Q^z_n can be expected almost as efficient as that in Q_n. Since Q_n can be embedded onto Q^z_n with dilation 2 and congestion 2, Q^z_n can simulate Q_n and many other useful network efficiently. We generalize the Z-cube to obtain other new classes of networks. For example, a generalized n-dimensional Z-cube has diameter n, degree 5n/8 and 5/8 less of edges than Q_n and Q_n can be embedded onto it with dilation 3 and congestion 4.

PARK, Eun K., Associate Professor, "Towards an Efficient Deadlock Resolution Technique," *Proceedings* of the International Conference Parallel and distributed Computing and Systems, 1-3 October 1992, Pittsburgh, Pennsylvania, pp 71-74.

For a fairly wide variety of database workloads and system configurations, locking is the concurrency control strategy of choice. Along with this comes the possibility of deadlocks which has a bad impact on the performance of the system. The throughput and the response time of the system goes down as the system resources are not fully utilized. This paper discusses deadlock resolution techniques and presents a new and efficient technique based on a new victim selection criteria called Min Resource-Queue for resolving deadlocks. A comparison in the performance of this technique has been made with the Min lock technique. The results were corroborated from the simulation model of a database environment. It was found that for almost twice the cases Min Resource-Queue scheme performed better than the Min Lock scheme.

PARK, Eun K., Associate Professor, "Replicated Databases on a Hypercube Using the Multicast," *Proceedings* of the International Conference on Computer Communications and Networks, (ICCCN), 8-10 June 1992, San Diego, California, pp 314-317.

Distributed database systems consist of a number of nodes which are connected by a communication network. The data objects are partially replicated to improve availability and performance. Partially replicated databases present a number of design considerations. They are the placement of copies and the degree of replication. This paper considers only an optimal replication scheme of data objects, i.e., at which processors in the network the replicas should be located. Simulation of partially replicated database running on a hypercube is used to analyze placements of replicated data objects. The simulation study focuses on placement of data items from the communication cost point of view, i.e., in terms of message complexity. As we know in replicated databases the number of messages required to propagate updates to copies has to be

minimized. The minimum spanning tree, by which a processor on a hypercube should multicast a write of a data item, is shown to be optimal from the communication cost point of view. An efficient multicase policy provides message delivery to a group of processors at a lower network and processor overhead than broadcasting to all processors or unicasting to each processor in a group.

PARK, Eun K., Associate Professor, "Processor Validation in Embedded Real-Time Systems," *Proceedings* of the International Conference on Computer Applications in Design, Simulation and Analysis, March 1993, Washington, DC, pp 254-259.

A method is presented for the validation of the processors in an embedded multi-processing system. The algorithm discussed assumes a single failure in the system at any given time. This algorithm defines a buddy system in which each processor votes on the health of its logical neighbors. The architecture consists of six processors, one used as an input/output manager, four used for online processing, and one which serves as a hot standby. The processors communicate via a Virtual Memory Extender (VME) bus. In order to provide the confirmation of a failed processor the algorithm requires that a majority exists among the voting processors. In this way, a failed processor cannot take a healthy processor off line. Other benefits of this algorithm are also discussed, such as software commonality and expandability. Reconfiguration within specific run-time constraints is addressed. The message protocol and the redundant configuration are also addressed. In addition, several other validation schemes, message protocols, and redundant configurations are compared to the above strategies.

PARK, Eun K., Associate Professor, "Design of a Network Interface Adapter for Hybrid LANs," *Proceedings* of the IEEE 34th Symposium on Circuits and Systems, June 1992, pp 455-458.

Since local area networks (LANs) have become a vital part of modern computing, a great deal of effort has been devoted to their design, standardization, and implementation. Most of this work has been based on a simple linear bus or ring topology (Ethernet, Token Bus, and Token Ring). The linear bus and ring topology networks have significant disadvantages in certain applications. However, some of the problems in existing LANS

can be solved with hybrid-architecture LANs such as Hybrid-Token Ring and Hybrid-Ethernet. The Hybrid-LANs allow an insertion or deletion of data links in existing local area networks such as Ethernet or token ring. This paper discusses a design of a network interface adapter (NIA) suitable for the Hybrid-LANs. Efficient load sharing through two communication channels is an important function of the NIA. The design of the message distribution device for a dynamic loading of messages is presented. This research provides a basic foundation for the implementation of Hybrid-LANs as well as other hybrid-type architecture LANs.

PARK, Eun K., Associate Professor, "A Token Based Distributed K Mutual Exclusion Algorithm," *Proceedings* of the IEEE Symposium on Parallel and Distributed Processing, December 1992, Dallas, Texas, pp. 408-411.

In this paper we present an algorithm for solving the k mutual exclusion problem in a distributed system. Our algorithm is "Token Based," whereby a token is passed among sites. Only sites that either receive the token with a non-zero semaphore or receive the token with a zero semaphore and later receive a release message from a previous site, are allowed to enter their critical sections. Attached to the token is a queue which lists the sites scheduled to receive the token and a general semaphore. In all cases except extremely light token request traffic, the number of messages per critical section execution can be expressed as a small constant. This constant approaches 3 in an extremely heavy token request environment.

PHILLIPS, Andrew T., Assistant Professor, co-author, "Sufficient Conditions for Solving Linearly Constrained Separable Concave Global Minimization Problems," Journal of Global Optimization, Journal, 3 (1993) pp. 79-94.

A concave function defined on a polytope may have many local minima (in fact every extreme point may be a local minimum). Sufficient conditions are given such that if they are satisfied at a point, this point is known to be a global minimum. It is only required to solve a single linear program to test whether the sufficient conditions are satisfied. This test has been incorporated into an earlier algorithm to give improved performance. Computational results presented show that these sufficient conditions are satisfied for certain types of problems

and may substantially reduce the effort needed to find and recognize a global minimum.

PHILLIPS, Andrew T., Assistant Professor, co-author, "Efficient Computation of Extreme Points of Convex Hull in R^{d1}," *Advances in Optimization and Parallel Computing*, Elsevier Science Publishers B.V., pp 267-292.

The problem of finding the extreme points of the convex hull of a given finite set of points is considered. A new parallel algorithm is presented for solving this problem.

PHILLIPS, Andrew T., Assistant Professor, "A Computational Comparison of Two Methods for Constrained Global Optimization," Army High Performance Computing Research Center Report 92-042. Minneapolis, Minnesota.

For constrained concave global minimization problems, two very different solution techniques have been investigated. The first such method is a stochastic multistart approach which typically finds, with high probability, all local minima for the problem. The second method is deterministic and guarantees a global minimum solution to within any user specified tolerance. It is the purpose of this paper to make a careful comparison of these two methods on a range of test problems, and to investigate in this way the advantages and disadvantages of each method. A direct computational comparison, on the same set of over 140 problems, is presented.

PHILLIPS, Andrew T., Assistant Professor, "A Quadratic Assignment Formulation of the Protein Folding Problem," The University of Minnesota Supercomputer Institute Research Report UMSI 92/223. Minneapolis, Minnesota.

The protein folding problem is discussed, and a concave quadratic global minimization approach for solving the problem is described. This approach is based on a quadratic assignment formulation of a discrete approximation to the original problem.

SCHULZE, Kay G., Associate Professor, co-author, "Brevity Code Performance Issues in AEGIS Communications," Naval Research Laboratory Report, May 1993.

Communications are a crucial aspect of military decision making. In the AEGIS Combat Information Center (CIC) context, verbal communications and the use of computerized combat systems and computerized displays interact to produce effective team performance. We recorded the internal CIC communications during AEGIS team training exercises and developed a classification scheme to categorize each communication. The team communications were coded and analyzed at the speech turn level with emphasis on the distinctions between speech turns which included the use of brevity codes and those which did not. The changes in communication patterns for a single team from early to late training were used to evaluate hypotheses about effective communication. The use of brevity codes and standard vocabulary was fairly consistent across training, but the effectiveness of brevity codes in minimizing the use of ordinary language remains in question.

Changes observed with increased training include a slight reduction in format deviations for non brevity code speech turns, but the same was not true for brevity code speech turns. Interpreted data is fairly consistent across training, but more frequent in brevity code speech turns than in the transcripts in general. The repetitions and error categories show no consistent trends.

These results have implications for planning training strategies including the use of performance feedback in training, and provide data relevant to the evaluation of training effectiveness.

Presentations

BEDAR, George R., Major, USMC, "Ada Generics," 7th Annual ASEET Symposium, Monterey, California, 12 January 1993.

BEDAR, George R., Major, USMC, "Ada Numberics," 7th Annual ASEET Symposium, Monterey, California, 12 January 1993.

CHI, Frank L.K., Professor, "Cosmology Wonders," Sigma Xi Meeting, United States Naval Academy, Annapolis, Maryland, 16 September 1992.

HARRISON, Patrick R., Professor, "Review of Artificial Intelligence Research Program in Intelligent Decision Aids," Office of Naval Research Computer Technology Spring Review, San Diego, California, 6 April 1993.

HARRISON, Patrick R., Professor, "Implementation Issues for Cased-Based Reasoning & Planning," Internal Seminar, Naval Research Laboratory, Center for Applied Research Artificial Intelligence, 27 October 1992.

HARRISON, Patrick R., Professor, co-author, "New Developments of a Knowledge Based System (VEG) for Inferring Vegetation Characteistics," International Geoscience and Remote Sensing Symposium, Houston, Texas, 26-29 May 1992.

PARK, Eun K., Associate Professor, "Replicated Databases on a Hypercube Using the Multicast," International Conference on Computer Communications and Networks (ICCCN), San Diego, California, 8-10 June 1992.

PARK, Eun K., Associate Professor, "Design of a Network Interface Adapter for Hybrid LANs," at the IEEE 34th Symposium on Circuits and Systems, Monterey, California, 8 June 1992.

PARK, Eun K., Associate Professor, "Towards an Efficient Deadlock Resolution Technique," International Conference on Parallel and Distributed Computing and Systems," Pittsburgh, Pennsylvania, 1-3 October 1992.

PARK, Eun K., Associate Professor, "A Comparative Case Study in Object-Oriented Systems Analysis Methodologies," Conference on Design, Analysis and Simulation, Washington, DC, 10-12 March 1993.

PARK, Eun K., Associate Professor, "Processor Validation in Embedded Real-Time Systems," International Conference on Computer Applications in Design, Simulation and Analysis, Washington, DC, 10 March 1993.

PHILLIPS, Andrew T., Assistant Professor, "A Computational Comparison of Two Methods for Constrained Global Optimization," Army High Performance Computing Research Center, Minneapolis, Minnesota, 10 July 1992.

PHILLIPS, Andrew T., Assistant Professor, "A Quadratic Assignment Formulation of the Protein Folding Problem," United States Naval Academy, Annapolis, Maryland, 4 November 1992.

PHILLIPS, Andrew T., Assistant Professor, "Pipeline Control of High Performance Computers," Carleton College, Northfield, Minnesota, 22 February 1993.

PHILLIPS, Andrew T., Assistant Professor, "Protein Folding by Minimization on the CM-5," ORSA/TMS Joint National Meeting, Chicago, Illinois, 18 May 1993.

SCHULZE, Kay G., Associate Professor, co-author, "Communication Behavior in the Context of a Team Decision Task," Fourth Annual Navy R&D Information Exchange Conference, San Diego, California, 13 April 1993.

Mathematics

Professor James M. D'Archangelo
Chair

Mathematics provides a logical framework and a language indispensable to understanding the world in which we live. The following pages summarize the many contributions to this field of study made during the past year by the faculty and students of the Naval Academy. The results cited reveal the great scope and diversity of mathematics and offer glimpses of its intellectual beauty and appeal.

Six midshipmen, participating either in the Honors Mathematics Major or in special research project courses, teamed up with faculty advisers to apply their mathematical skills to a variety of interesting problems. For example, Midshipman R. Scott Thomas worked with Professor Thomas J. Sanders analyzing the capabilities of ProModelPC (a modern simulation software tool), to determine if it could be used to study the personnel flow of a ship and to determine the inputs that would be needed if NAVSEA decided to use it. Midshipmen Brian C. Bender and Michael D. Kozub worked with Professor W. Charles Mylander and Dr. Daniel Wagner developing a prototype software package for automated track reconstruction of a non-cooperative target ship.

This past academic year was a very productive one for the faculty. Over thirty research articles appeared in refereed journals published throughout the United States and abroad. The topics covered in these articles are as varied as mathematics itself. They range from the "applied" areas of submarine detection, automated fingerprint identification, the buckling of rods, and the fracturing of ice formations, to the "pure" areas of harmonic functions, C*-algebras, and number theory.

Over fifty research projects were conducted by members of the Mathematics Department with the support of a variety of sources such as the National Science Foundation, the Johns Hopkins University Applied Physics Laboratory, the Naval Surface Warfare Center, the Naval Academy Research Council, the Naval Academy Instructional Development Advisory Committee, the NASA Goddard Space Flight Center and Robotics Laboratory, the American Mathematics Society, the Office of the Chief of Naval Research, the American Society for Engineering Education, the Federal Bureau of Investigation, the Los Alamos National Laboratory, and the Office of Naval Technology.

During the past year, department members presented the results of their work on sixty-eight different occasions at professional mathematical meetings and colloquia throughout the United States and abroad. This activity, along with publication, enhances the academic stature of the Naval Academy and promotes the professional growth and reputation of those individuals involved. Through research activity, the faculty learn of and take part in the discovery of new mathematics. This new material and ideas can then be shared with midshipmen in advanced courses.

Sponsored Research

A Study of Non Acoustic Counter Measures

Researcher: Professor Pierre P. Andre
Sponsor: Johns Hopkins University/Applied Physics Laboratory

Several new non-acoustic detection technologies have been developed by many of the maritime nations. This study examined the tactical advantages of one of these non-acoustic

technologies and studied possible counter measures to protect U.S. SSBN's against this detection technology.

Placement of LFAR Detectors

Researcher: Professor Pierre P. Andre
Sponsor: Johns Hopkins University/Applied Physics Laboratory

Low frequency acoustic detection systems have very long ranges and long return times. In a given search party, it is tactically useful to have one source but many receivers on different platforms. The study examined the best locations for the receivers relative to the source. A simple model for bistatic reception was built and the optimal locations of three receivers were determined.

Hypermembrane Shells

Researcher: Professor James L. Buchanan
Sponsor: Naval Academy Research Council (OMN)

Hierarchical shell theories seek to provide sets of momentum balance and constitutive equations the dimension of which can be varied to increase the accuracy with which the theory approximates the stresses and displacements within the shell. The investigator and R. P. Gilbert have introduced hypermembrane shells, a class of hierarchical shells for which the lowest order approximation reduces to the momentum balance equations of the classical membrane shell. This year the investigator succeeded in deriving a set of constitutive equations for hypermembrane shells. As in the case of membrane shells the momentum balance and constitutive equations appear to uniquely determine the stresses and displacements in the case of shells of positive Gaussian curvature. Whereas membrane shell theory provides approximations to the stresses and displacements only on a reference surface, hypermembrane shell theory provides approximations throughout the body of the shell.

Computer Aided Instruction in Probability and Statistics

Researchers: Professors Michael W. Chamberlain and
Harold M. Kaplan
Sponsor: Naval Academy Instructional Development
Advisory Committee

Professor Kaplan is the course coordinator for SM230, Introduction to Probability and Statistics, and Professor Chamberlain is the course coordinator for SM239, Probability and Statistics I. SM230 is an alternative fourth semester mathematics core course and is populated predominantly by Group III majors. SM239 provides majors in mathematics, computer science, and systems engineering a first course in probability theory. Both courses are evolving due to the nature of their students and to the impact of the personal computer. Hence the researchers set these objectives for their joint IDP of 1992-1993: to completely rethink and rework the statistics notes for SM230 and to align the statistics instruction of SM239 with SM230.

The researchers started to rethink and rewrite the SM230 Statistics Notes and computer software in the spring semester of 1992. Their experience in teaching the course led them to cut back on the breadth of statistics offerings and to give what remained a commonality they had lacked before. Most of the twenty-eight pages of notes that they created are devoted to modern, computer-intensive

nonparametric tests of hypotheses based on ranks and the chi-square variable. An introductory "What is Statistics?" section was added to the front with sections on Cross-Validation (polynomial regression) and Monte Carlo (simulations) added at the end. Computer-generated figures were developed and all of this material was professionally printed with the mathematical text formatter TeX. The software was made more "user-friendly" and menu driven.

An important aspect of the SM230 statistics notes is that they are covered in the course in parallel with the probability theory throughout the semester. This serves the purpose of showing the student one reason why probability is studied. And it avoids the usual crunch at the end of a one semester course when traditional statistics topics are hurriedly introduced after all the necessary theory has been covered.

With this same goal in mind, the authors set out to produce and test a similar program for SM239. Again, nonparametric statistics were involved. But the emphasis was placed on using existing commercial computer software, in this case Mathematical. Midshipmen can access this powerful software through NADN and their personal computers on the Mathematics Department file servers. By working through nine related projects, the students learn to produce probability distribution functions, read in data files and manipulate them as lists, to call up statistical packages, to perform nonparametric tests of hypothesis, and to compute confidence intervals. Indeed, mathematics courses in the future may very well be based on Mathematical as the primary computing tool.

Graph Matching and Image Processing Neural Networks for Fingerprint Identification for the Federal Bureau of Investigation

Researcher: Associate Professor Carol G. Crawford
Sponsor: The Federal Bureau of Investigation

This research presents findings of the second year of an ongoing co-operative research project with the Center for Theoretical and Applied Neural Science (CTAN) at Yale University. Together with Professor Eric Mjolsness, the investigator develop innovative applications of graph theory and neural networks to image processing, matching, and classification of fingerprints. They present theoretical results for each task, as well as software implementations of these ideas. Their approach makes essential use of inexact graph-matching formulations and neural networks to handle these tasks. For each task they apply relaxation based neural networks to minutia map representations of fingerprints.

Degaussing of Ships

Researcher: Associate Professor Gary O. Fowler
Sponsor: Naval Surface Warfare Center, Annapolis Laboratory

Ships can be detected from the magnetic field generated by the ship's hull and by the interaction of the ship's hull with earth's magnetic field. It is a goal of navies around the world to minimize the field generated by the ship. Thus decreasing the likelihood of a detection by an enemy. Typically coils are installed in the ship so that when currents are applied to these coils the resulting magnetic field minimizes the total magnetic field. This project is to establish, test, and evaluate mathematical models to predict the currents required in order to minimize the total field generated by the ship. The problem is complicated by the need for the mathematical models to work anywhere in the world. Models have been built and the project is in the test and evaluation stage.

Development and Analysis of a Numerical Method for Solving the Nonlinear Parabolic System Describing the Formation of Wing Cracks in Ice

Researcher: Assistant Professor Sonia M. F. Garcia
Sponsor: Office of Naval Research

The main goal of this analysis is to monitor the growth of the temperature at the tip of the crack. It is expected that the stress intensity factor at the tip of the crack will contribute to a sharp rise in the temperature in a small neighborhood of the tip of the crack. Ultimately, it is expected that the phenomenon of shear localization becomes the prevailing deformation. It is also expected that the temperature behaves in such a way that in some instances, the gradient of the veloc⋅ ⋅' blow up in finite time. This project wa⋅ ⋅rmed in collaboration with Donald French oi ⋅University of Cincinnati.

On the Smoothing Property of the Mixed Finite Element Method for Parabolic Equations

Researcher: Assistant Professor Sonia M. F. Garcia
Sponsor: Office of Naval Research

The researcher analyzed the Mixed Finite Element approximation of the general second-order parabolic initial-boundary value problem. For the second-order continuous time method with initial data only in L^2 the researcher expects to prove that the method can do at least as good as the Galerkin method, i.e., an L^2 error estimate of order $O(h^2/t)$. Some results are expected to be shown for the error in negative Sobolev norms and for the time derivative of the error. The researcher expects to use only elementary energy techniques based on parabolic duality arguments. The project was performed in collaboration with John Osborn of the University of Maryland.

The p-version of the Mixed Finite Element Method for Parabolic Equations with Time-dependent Co-efficients

Researcher: Assistant Professor Sonia M. F. Garcia
Sponsor: Office of Naval Research

The researcher intends to investigate the behavior of the p-version of the mixed finite element method when applied to linear parabolic problems with time-dependent coefficients. She wants to compare the performance of the mixed finite element method with quasi-uniform mesh with respect to the number of the degrees of freedom, whether the p-version will perform better than the h-version. The project was performed in collaboration with Soren Jensen of the University of Maryland.

Modified Saper Metrics and Singular Algebraic Varieties

Researcher: Assistant Professor Caroline G. Grant
Sponsor: Naval Academy Research Council (ONR)

This research project deals with the geometry of singular algebraic varieties. In earlier work funded by the Naval Academy Research Council, the researcher constructed modified Saper and Poincare metrics on the smooth part of any singular algebraic variety. In 1992, Ohsawa proved that the L2-cohomology of a singular algebraic variety with respect to certain modified Saper metrics is isomorphic to the intersection cohomology. The first part of the project is to demonstrate additional properties of modified Saper metrics and give examples and to show that a simpler metric may be used in Ohsawa's theorem. The second part is to study the relationship between modified Saper metrics and the deformation and stratification theory of singular spaces.

The researcher, in joint work with P. Milman of the University of Toronto, has already made progress toward solving the first problem. The researcher will show how modified Saper metrics in a sense keep track of the blow-ups used to resolve the singularities of a variety. Examples will be used to illustrate that constructing such metrics in specific cases is often quite easy.

Stability of Spacetimes with Mild Singularities or Cauchy Horizons

Researcher: Associate Professor Deborah A. Konkowski
Sponsor: National Science Foundation

The researcher studied mild singularities and Cauchy horizons in spacetime models. Mild singularities include quasiregular and nonscalar curvature singularities. In the former, particle paths may end with no accompanying physical catastrophes, while in the latter, some particles moving near the singularity will feel infinite tidal forces, but not all do. In most cases the spacetime models examined satisfy Einstein's equations.

In particular, the researcher used a conjecture proposed in her thesis and published with T. M. Helliwell in 1985 to predict whether various mild singularities and Cauchy horizons are stable. Thus far the conjecture has held true for the quasiregular singularities in Taub-NUT-type cosmologies and in Khan-Penrose spacetime when fields are added. When applied to the quasiregular singularity in Bell-Szekeres spacetime and the Cauchy horizon and nonscalar curvature singularity in a Type V LRS spacetime a prediction was possible but no exact spacetimes were available for comparison. A study of the Cauchy horizons in the Reissner-Nordstrom spacetime using the conjecture accurately predicted the effects of null dust when compared with exact solutions.

The researcher plans to continue to use the conjecture to study the stability of the Cauchy horizons in the Kerr spacetime and the singularities in plane-wave-cosmic string spacetimes, global cosmic string models, tilted Class B Bianchi cosmologies with whimpers, and certain spherically symmetric dust shell models with quasiregular singularities. She also plans to test the conjecture using spacetimes with Weyl curvature singularities.

On the Essential Spectrum of Laplaceans

Researcher: Associate Professor Robert Lockhart
Sponsor: Naval Academy Research Council (OMN)

The goal was to show that certain isoperimetric inequalities defined on manifolds with ends could be

used to classify those Laplaceans on such manifolds that have O in their essential spectrum and those that have empty essential spectrum.

The inequalities were shown to provide sufficient conditions not only in the case of manifolds with ends, but in general. Furthermore, connections with classical function theoretic problems were made. In particular it was shown that if M is of dimension $\geq$ 3, then every metric on M is conformal to a parabolic one.

In a different vein, it has recently been shown that if (M,δM,g) is a compact manifold, perhaps with boundary, then the wave equation on M (with appropriate boundary conditions) has infinitely many multiple eigenfrequencies if (M,δM) has an isometry of orders 3 or more.

Stability, Bifurcation, and Fracture in Ice Mechanics

Researcher: Professor Reza Malek-Madani
Sponsor: Office of Naval Research

This proposal concerns three sets of partial differential equations that model the formation of wing cracks in ice, flow of ice-ocean fluid in the Arctic region, and the influence of Arctic ocean internal wave packs on ice flexure.

The first set of differential equations will model a block of ice under uniaxial compression. Ice will be modelled as an anisotropic thermally conducting material with a nonlinear constitutive law. Using the three dimensional formulation of the problem, the formation of wing cracks as a primary-secondary bifurcation problem will be established. The stability of wing cracks as equilibrium solutions of the governing equations will be one of the goals of this part of the proposal. Another goal of this work will be to compare the critical values of the loads that trigger the onset of wing crack formation with the available data of the experimental work of E. Schulson.

For the second set of equations the main points of concern are the existence of global weak solutions for the kind of nonlinearities that model ice deformation as a compressible visco-plastic material. These equations of motion have been introduced by W. D. Hibler and have received some analytical and numerical treatments in the past. Because the flow is two dimensional, recent results on quasilinear parabolic systems will be used to extract the existence theorem. Then, in order to resolve a question concerning the localization of the flow near coastal boundaries, steady-state solutions of the system will be studied in a circular domain. The solutions will be cast as minimizers of proper nonlinear functionals and their stability as solutions of the full dynamical system will be established.

The third set of equations were motivated by the experimental results of measurements of ice tilt during the Coordinated Eastern Arctic Experiment (CEAREX) and the ensuing discovery of internal waves on the Yermak plateau. The purpose of this part of the proposal is to develop a mathematical model for the experimental work and prove the existence of solitary waves for this model.

Fractal Structure of Radar Sea and Rain Scatter

Researcher: Professor Mark D. Meyerson
Sponsor: Naval Research Laboratory and Naval Academy Research Council (ONR)

Extensive data was available from NRL (about 200 separate rain or sea cells, each with 1024 or 1750 pulses). The method of correlation exponent (due to Grassberger and Procaccia) was shown to be more useful than the classical box counting method for approximation dimension. Programs were developed to apply this method to the data cells, thereby arriving atestimates to the dimension. The radar used was coherent, producing both in-phase channel and quadrature channel data. Dimension was estimated in several different ways including: using each channel separately, using their root mean square (magnitude), and treating them as the real and imaginary parts of a complex number. In almost all cases, there seemed to be an attractor with dimension between 5 and 10.

Shifts on Factors

Researcher: Professor Geoffrey L. Price
Sponsor: National Science Foundation

One of the key problems in the theory of von Neumann algebras is to study and to classify the position of subfactors of a prescribed index in the hyperfinite II_1 factor. In many ways this problem resembles the analysis of subgroups in group theory: the group theoretic notions of index, normality, and conjugacy all have analogues in the index theory for subfactors. Over the past few years the researcher has worked jointly with R. T. Powers to study a family of subfactors in the hyperfinite II_1 factor on which one can define a sort of non-commutative Bernoulli shift. For each factor in this family there is a corresponding bitstream of O's and 1's which

determines the behavior of the shift. The structure of the bitstream is reflected by certain properties possessed by the shift. By using the powerful new tools developed by S. Popa on commuting squares of von Neumann algebras, the authors hope to verify their computer evidence that suggests that all shifts of index 2 are cocycle conjugate. The authors have made some progress toward relating some properties of the bitstream, such as randomness, to properties of shifts. This work should help to give insight to the cocycle conjugacy problem. Two papers on this subject were submitted and accepted for publication during this period.

Cores for Unbounded Operators

Researcher: Professor Geoffrey L. Price
Sponsor: National Science Foundation

An unbounded operator S on a Hilbert space $\mathcal{H}$ is called symmetric, or formally self-adjoint, if the domain $D(S)$ of S is a dense linear subspace of $\mathcal{H}$ and if $(Sx,y) = (x,Sy)$ for all elements x,y of $D(S)$. In past work with P. Jorgensen, the researcher has considered the problem of determining whether $D(S)^{\otimes}D(S)$ is a core for the domain of the operator $S^{\otimes}I + I^{\otimes}S$ on the tensor product space. The researchers have recently generalized this work to show that for any formally normal operator N on $\mathcal{H}$,

$N^{\otimes}I + I^{\otimes}N$ has $D(N)^{\otimes}D(N)$ as a core for its domain. This work has useful application as a technical tool in the study of the second quantization of unbounded operators on Fock space. A current investigation is underway to determine whether the core property is true for all densely defined unbounded operators on a Hilbert space. The authors suspect that the property is not true in general and hope to find a way of determining the obstruction.

Cruise Missile/TACAIR Effectiveness Assessment Software

Researcher: Professor Thomas J. Sanders
Sponsor: The Johns Hopkins University Applied Physics Laboratory

This project involved the continued development of a cruise missile and tactical air (TACAIR) effectiveness assessment system that is being done by the Strike and Anti-Surface Warfare Group of the Naval Warfare Analysis Department of the Johns Hopkins University Applied Physics Laboratory (APL). The purpose of this system is to aid an analyst in scenario development, scenario analysis, survivability analysis, mission planning, and

equipment performance prediction. During the summer of 1992, this investigator added options and improved the DTED map program (DTM) that he wrote during the summer of 1991, and he began the development of a new program that will be part of the user interface of the group's Integrated Air Defense System (IADS) simulation. The DTM program was written in the C language and may be used by an analyst to display and manipulate Digital

Terrain Elevation Data (DTED) files. The IADS program is being written using MacApp, a C++ based, object oriented language for the Macintosh computer.

The DTED files are data files generated by the Defense Mapping Agency and are used in aspects of cruise missile mission planning. In particular, they are used by an analyst to assist in scenario analysis to investigate such things as radar site location and masking, and cruise missile flight paths. The DTED map program developed allows for computer generated color displays of the (large) data files quickly, and allows the analyst to use the computer to determine radar site locations and masking, and to plan cruise missile flight paths.

The IADS program is being developed to provide a simulation model that can be used in survivability and effectiveness studies of strikes against an integrated air defense system. The interface that the investigator began developing will provide an analyst with a tool to set up a scenario to be studied and will facilitate the placement of radar sites, vehicle (cruise missiles and/or aircraft) routes, target locations, command centers, etc. It will also use the DTED data files to give the analyst a terrain elevation map of the region of the scenario.

Electromagnetic Signature Reduction

Researcher: Professor John C. Turner
Sponsor: Naval Surface Warfare Center, Annapolis

Work is continuing on this classified project. Sea trials for December 1992 showed good results at using previous models and constructing new models with additional sensors. A preliminary attempt at a second geographic location was hampered by bad weather. Additional sea trials are scheduled for the Summer of 1993 with the goal of proof-of-concept for extending our model to additional geographic locations. Scale model work is nearing completion to allow further refinement of sensor placement.

Application of RNS Arithmetic to Adaptive Beamforming

Researcher: Associate Professor Peter R. Turner
Sponsor: Naval Air Warfare Center and
Naval Academy Research Council (ONR)

Beamforming is the tuning of an array of antennas so as to maximize the reception in the direction of a desired signal while minimizing the signal strength in the direction of a jammer signal. The antenna array could consist, for example, of radio antennas or sonobuoys. In the situation where the platform carrying the receiving antennas and/or the transmitting station is moving (such as an aircraft) then the array must be continually returned and this must be achievable in a very small time-frame. This is known as adaptive beamforming. Space is also at a premium and so the computing devices used must be physically small. The speed and size requirements imply that conventional computing equipment and standard solution techniques are not suitable.

The objective was to develop a technique of solution for the adaptive beamforming problem which could be implemented in a physically small unit. This implies the search for the right algorithm-arithmetic-architecture combination. The specific objective was to develop such a solution using Residue Number Systems and the associated RNS arithmetic for which a prototype processor has been developed for NAWC by a team from the University of Florida. Residue number systems represent an integer by its residues modula a basis set of prime numbers. The arithmetic is then performed on these residues relative to the appropriate moduli. The representation is unique for integers within the range of the product of the basis-moduli.

There are two principal mathematical formulations of the beamforming problem which reduces to finding the appropriate complex weights, which represent relative amplifications and phase shifts to be applied to the elements of the antenna array, so as to maximize the desired signal while

reducing the effect of the jammer signal. One of these results is the need to solve a (complex) linear system of equations for the weights. The coefficient matrix for this system is covariance or correlation matrix of a collection of "snapshot" vectors of the received signal on the elements of the processor array. This formulation of the problem was the subject of the research.

The solution can easily be achieved on a conventional computer by a variety of well-known algorithms using standard floating-point arithmetic. This would be too slow and too cumbersome for the desired purpose. Residue Number Systems and the associated RNS arithmetic offer the potential for very fast arithmetic since all internal arithmetic is performed on short-word integers. However, there are difficulties: the integers are not closed under division or square-root operations, for example. This rules out the use of and the standard tools of numerical linear algebra unless the non-RNS operations can be eliminated or at least minimized so as to reduce the cost of conversion between the RNS and other arithmetic systems.

The proposed solution is to modify the Gauss elimination algorithm by eliminating the divisions entirely. However, the cost of this is rapid growth in the magnitude of the matrix elements as the elimination proceeds. This is in conflict with the restricted dynamic range offered by RNS arithmetic systems.

The solution developed is to use a column-parallel, parallel-channel implementation of Gauss elimination in which an array of RNS-processors is used adaptively. The basic idea is that the array is subdivided so that initially each column uses the same number of processors each working with the same basis-vector of moduli. As the elimination proceeds, the processors are reassigned so that the reduced number of "active" columns have more processors with new elements being introduced to the basis-vector. This allows the dynamic range to grow as the computation proceeds. For the particular solution proposed, the desired dynamic range still grows faster than can be accommodated just by this reassignment of the processors. A limited amount of scaling is therefore incorporated into the algorithm to overcome this difficulty.

The theoretical development of the algorithm-arithmetic-architecture mix has been developed and analyzed. The next stage is the simulation and testing of the algorithm to get realistic estimates of solution times. This should then be followed by a detailed description of the proposed architecture and the design of a prototype unit for practical testing.

Implementation and Applications of Level-Index Arithmetic

Researcher: Associate Professor Peter R. Turner
Sponsor: Naval Academy Research Council (ONR)

The proposal was to continue with the development of possible schemes for the eventual hardware implementation of LI arithmetic and the analysis of the algorithms used while at the same time gaining more computational experience and evidence of the potential practical value of the system via applications using software implementations of the level-index, LI and symmetric level-index, SLI arithmetic system. This was a continuation of previous work on the level-index system. This system has the virtues of eliminating overflow and underflow and using a consistent and appropriate measure of precision throughout the range of the real numbers. The advantages are offset by the fact that arithmetic will be slowed down. However, the fact that the programmer or software designer would be freed from worries about potential overflow and therefore from the need to scale problems will in many cases more than balance this loss.

The principal objectives were to investigate further the implementation and application of LI and SLI arithmetic and the comparison of these with other proposed new computer arithmetics. Specifically this has led to the acceptance for publication of a paper in the *Proceedings* of the 11th IEEE Symposium on Computer Arithmetic on the implementation and error analysis of complex SLI arithmetic. A related paper co-authored with D. W. Lozier of NIST on reliable computation of vector norms in floating-point and SLI arithmetics has been published in Computing. Another paper with Lozier has been published in the NIST Journal of Research. This begins the study of the use of SLI arithmetic within simulation and modeling, considering problems from turbulent combustion

and data-fitting for compound exponential decays such as radioactive decay. A shortened version was published in the *Proceedings* of the 23rd Pittsburgh conference on Modeling and Simulation.

The methods of investigation included mathematical analysis, the development and use of algorithms for various arithmetic systems and their application to the evaluation of mathematical functions. This included a comparative study of the various schemes. The study also included research into recent hardware design developments and their possible use in eventual implementations of the level-index scheme. The other major areas of activity here have been and are concerned with the use of parallel processors and the implications of the parallelism for the arithmetic system used.

The principal output of this research has been in the form of research papers and the development of ideas for further developments and publications.

The work is still very much alive and is likely to be continuing for several more years. It is a major undertaking involving at least four principal active contributors.

Independent Research

Regular Steinhaus Graphs

Researcher: Associate Professor Craig K. Bailey

A Steinhaus graph is derived from a symmetric matrix of O's and 1's, with O's on the main diagonal, with $a_{1,j}$ for $j > 1$ a bitstream of 0's and 1's, and $a_{i,j}$ for $j > i$ defined by $a_{i,j} = a_{i-1,j-1} \oplus a_{i-1,j}$ where $\oplus$ is mod 2 arithmetic.

A graph is regular if all of its points have the same degree. An old conjecture says that there are no regular Steinhaus graphs of odd degree. With the help of computer programs from an undergraduate research project at Washington and Lee University, some progress has been made.

Applications of Graph Theory to Parallel Processing

Researcher: Associate Professor Carol G. Crawford

This project is a continuation of a project with Stuart Ullman, Naval Surface Warfare Center, Bethesda, Maryland. The investigators combine their respective backgrounds in parallel processing and graph theory to present innovative algorithms for mapping the subtasks of a parallel task to the processing elements of a parallel computer. In particular, they develop a theory of task graph partitioning as the first step in mapping parallel algorithms to parallel architectures. This theory interprets the mapping problem in terms of graph colorings.

Total Colorings and Chromatic Polynomials

Researcher: Associate Professor Carol G. Crawford

This research continues a long term research program with Professor Ruth Bari, Professor Emeritus of George Washington University. Together, the authors have written various papers presenting their results in Near Chromatic Polynomials and Almost Proper Colorings of the Edges of a Graph. In their latest investigation they explore generalizations of this theory to total colorings of graphs which include colorings of both the vertices and edges of graphs. These

generalizations are then applied to the development of algorithms to generate chromatic polynomials for total colorings.

Generalizations of Free Groups

Researcher: Professor Anthony M. Gaglione

Let P be a presentation of a group G. Then relative to P one constructs the Cayley graph X of G. The group G then acts freely via graph automorphisms on X. If G is a free group and the presentation P is the standard one with the empty set of defining relators, then X is a tree and no element of G inverts an edge of X. Conversely we know from the Bass-Serre theory that any group which acts via graph automorphisms freely and without inversions on a tree is necessarily a free group.

Structures more general than trees in the ordinary sense have now been introduced; in particular, if Λ is an ordered Abelian group, then one can define a Λ-tree (as done by Bass and others.) For $\Lambda = Z$ with the usual order, a Λ-tree becomes an ordinary tree. In this project, we consider questions concerning groups which act via Λ-isometries freely without inversions on some Λ-tree X for some ordered Abelian group Λ. The researchers also consider questions involving groups which satisfy every first order property of free groups (but may not themselves be free). Other generalizations of free groups considered here are the so called n-free groups, i.e., groups all of whose n-generator subgroups are free for some positive integer n. Finally, the relationships of all of the above are considered to the word hyperbolic groups of Gromov. The researchers have many partial results, but the project is still very much in progress.

A Corrected Derivation for the Special Theory of Relativity

Researcher: Professor Robert A. Herrmann

It is shown that all the known derivations for the Special Theory of relativity are logically inconsistent. Using properties of the nonstandard physical world, a new fundamental derivation for all of the effects of the Special Theory is given that eliminates the logical inconsistency. Using Robinson infinitesimal, infinite numbers and infinitesimal light-clock analysis, it is shown that all Special Theory effects are but manifestations of the interaction between the natural world and a nonstandard substratum. This analysis eliminates the controversy associated with the physically unexplained universal time dilation and length x contraction. It is shown that no such concept as time dilation or length contraction is necessary to explain all associated laboratory findings. Rather, all such findings follow from necessary alterations in pure numerical quantities associated with an electromagnetic interaction with the NSP-world substratum. These numerical alterations appear to be caused by the nonlinear path of propagation of electromagnetic effects within an infinitesimal light-clock when viewed from the NSP-world.

Logically Consistent Derivations for Conclusions Associated with the General Theory of Relativity

Researcher: Professor Robert A. Herrmann

In this research, in order to eliminate the logical inconsistencies associated with the General Theory, the concept of the privileged observer is accepted with such an observer being located within a

nonstandard substratum. Further, all results are obtained without the use of the general principle of relativity. In particular, the Einstein Special Theory line element is derived from basic infinitesimal light-clock analysis and shown to be related to the propagation of electromagnetic radiation. Suppose that a natural system's behavior is governed by a seperable function

$$T(x_1,x_2,...,x_n,t) = H^s(x_1^s,x_2^s,...,x_n^s)f(t^s)$$

defined on an open neighborhood of $(x_1,x_2,...,x_n,t)$ that satisfies an expression $D(T) = (D(H^s))f(t^s) = k(\partial T/\partial)$, where D is a (functional) operator. It is shown that this expression determines two appropriate eigenvalue relations associated with the oscillatory properties of the nonstandard substratum. When D is the classical hamiltonian operator associated with the time-dependent Schrodinger equation for an atomic system, the Ives-Stillwell (Special Theory) redshift is derived from one of these relations and, when a Newtonian gravitational potential is inserted into the other relation, the gravitational redshift expression is derived. Finally, a general expression is derived from infinitesimal theory applied to an obvious Galilean measure for the distance traversed by an electromagnetic impulse where the oscillatory nature of the nonstandard substratum is damped by a nonreversible process P. Various metrics, such as the Schwarzchild and others, are obtained by simply substituting different P-related velocities into the general expression.

Multiple Harmonic Series

Researcher: Associate Professor Michael E. Hoffman

The purpose of this research is to resolve some conjectures (called the duality and sum conjectures in an earlier publication) about the multiple harmonic series

$$A(i_1, i_2, \cdots, i_k) = \sum_{a_1 > a_2 > \cdots > a_k \geq 1} \frac{1}{a_1^{i_1} a_2^{i_2} \cdots a_k^{i_k}},$$

where $i_1, i_2, \cdots, i_k$ are positive integers with $i_1 \geq 2$.

Results: If the researcher gives the set of formal sums of sequences $(i_1,i_2,...,i_k)$ as above the structure of a (noncommutative) ring with juxtaposition of sequences as the multiplication, then A can be regarded as a function from this ring into the reals (it is a homomorphism of abelian groups, but not of rings). The "duality conjecture" of the author may be rephrased as asserting that A is invariant under a certain period-2 antiautomorphism of this ring. The author has proved some results about the combinatorial structure of this ring, and has recast some of his earlier results in a more algebraic, and simpler, form. The author has also written a set of computer programs to strengthen numerical evidence for the duality and sum conjectures: the data generated may lead to the discovery of further relations among the series. Finally, he is currently investigating whether C^*-algebra techniques may shed any light on the problem. Work continues on the items mentioned above.

Restricted Orbit Equivalence for Actions of $\mathbf{Z}^d$

Researcher: Associate Professor Janet W. Kammeyer

The central question in Ergodic Theory is to ask whether two dynamical systems are "the same." For example, suppose (X,A,μ) is a Lebesgue probability space. Let T be a measure preserving, finite

entropy ergodic Z-action on (X,A,μ). Two such systems are said to be orbit equivalent if there exists a bimeasurable, measure preserving map Φ between them which preserves the T-orbits, as sets. In 1959, H. Dye proved that any two ergodic Z-actions are "the same," in the sense that they are orbit equivalent.

If more restrictions are placed on this orbit equivalence Φ, so that, for instance, the map Φ must also preserve the order of the orbits, then any two ergodic Z-actions which are orbit equivalent in this restricted sense are said to be isomorphic. In 1970, D. Ornstein proved that any two Bernoulli (i.e., independent) Z-actions of equal entropy are "the same," in the sense that they are isomorphic.

These two notions "sameness" may be thought of as two ends of a spectrum of restricted orbit equivalence, with orbit equivalence putting essentially no restriction on Φ and isomorphism putting a quite rigid restriction on Φ. In 1985, D. Rudolph published a general theory of restricted orbit equivalence for Z-actions. He defined the

"size," m, of an orbit equivalence, and defined what it meant for two Z-actions to be "the same" in the sense of being m-equivalent. He then proved a theorem which gave a characterization of those Z-actions which are m-equivalent.

This researcher, working jointly with D. Rudolph (University of Maryland), has developed a notion of restricted orbit equivalence for ergodic actions of the higher dimensional group Z^d. The concept of a "size" is first developed from an axiomatized notion of the size of a permutation of a finite block in Z^d. This is extended to orbit equivalences which are cohomologous to the identity and, via the natural completion, to a notion of restricted orbit equivalence. This is shown to be an equivalence relation.

This work has been submitted for publication. The authors are also continuing this work by proving a theorem which characterizes those ergodic Z^d-processes which are equivalent in this restricted sense.

Integro-Differential Evolution Equations

Researcher: Associate Professor Thomas J. Mahar

Green's functions are used to reduce a non-separable pair of partial differential equations to a single integro-differential evolution equation in a Hilbert space. Laplace transforms and function theory are used to derive necessary and sufficient conditions for the existence of product solutions. The equation under study does not satisfy this

condition. The equation is solved by an infinite series of pseudo-modes which are all coupled to one another. A renewal equation is solved to determine the coupling term. The solution to the evolution equation then provides necessary and sufficient conditions for the stability of solutions to the original system of partial differential equations.

The Foundations of Continuum Mechanics and Untypical Problems

Researcher: Professor Reza Malek-Madani

The principal investigator, together with J. F. Pierce of U.S. Naval Academy and Clifford Truesdell of the Johns Hopkins University, are continuing their collaboration with Italian mathematicians in the group guided by Gianfranco Capriz of Pisa. Their contacts with this group were established during preceding visits made possible by the National Science Foundation U.S. -Italy program. They wish

to develop and, if possible, complete the recent reorganization of the mathematical foundations of continuum mechanics so as to cover rigorously defined materials of grade higher than one, including also the thermomechanics of such materials. They will attempt to solve associated problems of topology, functional analysis, and geometric measure theory.

Problems Associated With Maxwell's Equation

Researcher: Professor Peter A. McCoy

The Helmoltz partial differential equation is of fundamental importance in electromagnetics where certain waveguide, conductor or scattering solutions may be ascertained from boundary conditions satisfied by a function at the edge of a specified region. Efficient analytical or numerical methods for solution are under permanent consideration.

In applied mathematics, novel solution methods develop from techniques borrowed from apparently unrelated areas. This research places recent developments in Information Theory into a differential equations setting. The base is C.E. Shannon's classical sampling theorem which allows the replacement of a continuous bandlimited signal by a discrete sequence of points without loss of information.

A family of second order elliptic partial differential equations that include Helmholtz's equation are considered. Boundary value problems are solved on a class of bounded domains that include many regions of practical interest. Signal processing methods construct solutions from boundary data that is sampled at discrete sets of frequencies. Signal processing methods also lead to solution of Weiner-Hopf integral equations of the kind arising in scattering theory and to the solution of interpolation problems for analytic functions on plane domains.

A presentation was given at the 40th annual meeting of the Society for Industry and Applied Mathematics' (SIAM) session on Geometric Design and Approximation Theory (Los Angeles, California, July 23, 1992). Presentations will be made at the Mathematical Association of America Mid-Atlantic States Meeting (Baltimore, Maryland, November 1992) and the 99th Annual Meeting of the American Mathematical Society (San Antonio, Texas, January 1993). A paper detailing the solution of boundary value problems is being submitted to the SIAM Journal of Mathematical Analysis for publication. A second is being prepared.

Fractals and Chaos

Researcher: Professor Mark D. Meyerson

Fractal dimension and Lyapunov exponents can help quantify random appearing events such as radar backscatter. Such analysis can be used for clutter rejection schemes and for construction of a model for radar sea scatter.

Functions in Generalized Pinchuk Classes

Researcher: Associate Professor Edward J. Moulis

Let N be the set of all functions f analytic in $|z| < 1$, having the form $f(z) = z + \Sigma_2^\infty a_n z^n$. We continue our study of the class $U_k(\beta,c,\lambda)$ of generalized Pinchuk functions f in N which are defined by

$$\int_0^{2\pi} |Re\ [e^{i\theta}J_f - B\cos\lambda]|\ d\theta \le k\pi(1-\beta)\cos\lambda,$$

with $J_f = 1-1/c + zf'/cf$, $z = re^{i\theta}$, $0 \leq r < 1$, a non-zero complex number, $-\pi/2 < \lambda < \pi/2$, $0 \leq \beta < 1, k \geq 2$. When zf' is in $U_k(\beta, c, \lambda)$, f is said to belong to a generalized Moulis class $V_k(\beta,c,\lambda)$, named after this researcher who introduced the basic class $V_k(0,0,\lambda)$ in his Ph.D. thesis.

The researcher continues to try to find sharp bounds, in terms of the parameters k, β, λ, and c, the usual geometric mapping properties of functions in these classes, including distortion and rotation bounds as well as bounds on the series coefficients a_n .

The Navy and the JFACC: Making Them Work Together

Researcher: Lieutenant Commander Richard K. Phares, USN

During Operation Desert Storm, U.S. forces fought for the first time under a Joint Force Air Component Commander (JFACC). Because the Navy experienced some disadvantages operating in that environment, the Deputy Chief of Naval Operations for Plans, Policy and Operations asked the Center for Naval Analyses (CNA) to study "how to make the JFACC work the Navy."

CNR 202, titled, "The Navy and the JFACC: making them work together," is in final report form and has been sent to the sponsor for review. Conclusions were that the Navy's education, training, and equipment for joint air operations must rest on solidly designed and thoroughly tested joint doctrine. The Navy must ensure the doctrine: (1) Emphasized harmony of action among the elements of a joint force; (2) Explicitly charges the joint force commander to balance his use of air power between independent and direct support operations; (3) Defines the JFACC as the joint force commanders principle agent for achieving and adapting that balance; (4) Helps the joint force commander give his component commanders and the JFACC the right scope and level of guidance to ensure the balance; (5) and last, but not least, requires the JFACC to form and integrate joint air operations staff.

The researcher is a co-author of the final report.

A Brief Survey of the History of Air Operations

Researcher: Lieutenant Commander Richard K. Phares, USN

During Operation Desert Storm, U.S. forces fought for the first time under a Joint Force Air Component Commander (JFACC). Because the Navy experienced some disadvantages operating in that environment, the Deputy Chief of Naval Operations for Plans, Policy, and Operations asked the Center for Naval Analyses (CNA) to study "how to make the JFACC work the Navy."

CRM 92-196 titled, "A Brief Survey of the History of Air Operations," follows the development of air power usage throughout history, in order to understand why we have the system we have today. The paper examines: (1) the development of air forces by the major powers of the world; (2) the individuals who were largely responsible for their nations choice of doctrine; (3) the command and control systems learned (and sometimes relearned) by various nations; (4) whether technology was able to accomplish what the theorists want; and (5) what, if any, lessons are applicable to today's joint arena.

The paper is a supporting piece to the CNA final report (CNR 202, "The Navy and the JFACC: making them work together,") and is approximately 33% complete. The researcher is co-authoring the paper with Mr. Barry Messina of the Center for Naval Analyses.

Groebner Bases over the Integers

Researchers: Associate Professors George Nakos and Nickolas Glinos (Computer Science Department)

Between 16 June and 12 December 1992, the above named researchers contacted research in the very active area of Groebner Bases. Although originally designed to solve certain problems of computational commutative algebra, Groebner Bases crossed the borders between various areas of mathematics and computer science. Dr. Nakos' original motivation in the subject was a rather complex problem in algebraic topology but after a while it became clear that results obtained jointley with Dr. Glinos were applicable more generally. As part of this project, the researchers wrote a paper titled, "Groebner Bases over the Integers," currently submitted for publication. In this paper the authors implement in Mathematica an algorithm introduced by Bruno Buchberger that computes Groebner Bases of the ring of integers. This implementation may be of interest to workers in several areas of Mathematics and Computer Science.

The natural continuation of this project would be on developing criteria to improve the algorithm and make it faster.

The Use of Computers in the Core Calculus Courses

Researcher: Professor Howard L. Penn

The purpose of the project is to investigate the use of computers in the teaching of calculus. There are a number of objectives in the use of computers in the teaching of calculus. First is to help to illustrate the concepts of calculus. A second objective is stress the connection between the analytic and the graphical representation of functions and equations. Another objective is to place additional stress on the numerical topics in the course. Another objective is to be able to present more interesting and realistic applications of the study of calculus. Above all the objective is to make the students think about the mathematics rather than parrot a procedure without thought that they have seen the instructor use.

The Naval Academy has purchased a site license for Microcalc, a well respected program available for calculus. The researcher has also produced, with help from Professor James L. Buchanan, a *couple of programs*, MPP and MPP3D which are useful for the study of the subject. There is also a collection of computer assignments covering the three semesters of calculus that was produced. Each student, for the last several years, has received a copy of the software and uses it in the calculus courses.

The programs and assignments are used by almost all of the instructors teaching calculus. The collection of computer assignments do meet all of the goals outlined above and students are generally very receptive to their use. Naturally there are a few students who resist any effort to require them to think. In addition to its use at the Naval Academy, the researcher has received over 600 requests for the programs and computer assignments from instructors at other universities, colleges and high school including six other countries. MPP has been favorably reviewed in the College Mathematics Journal and there will be a review of MPP3D in the same Journal within a year. The programs have been described in a number of workshops throughout the country on software for the teaching of mathematics. Since the program is public domain, there is no way to determine the number of faculty members and students who have used these programs.

This is an ongoing project. MPP has been used for several years. During the last year, MPP3D which plots surfaces and curves in 3 space was written a year ago. A new module was added to MPP which is used to present infinite series. The computer assignments have and are still being revised. Documentation for MPP3D needs to be written and the computer assignments need to be revised.

Transversely Hemitropic and Transversely Isotropic Stress-Strain Relations

Researcher: Associate Professor John F. Pierce

The sets of polynomial stress-strain relations for elastic points which are transversely hemitropic and transversely isotropic are presented as algebraic projective modules having 20 and 10 generators, respectively. Complete sets of relations among the generators are presented which allow minimal representations to be deduced involving 10 and 6 generators, respectively. The results are established using the Cartan decomposition of the representation of the adjoint action of the two-dimensional rotation and orthogonal groups on the space of three-by-three symmetric matrices. The results are compared to known representations for nonlinear, transversely isotropic stress-strain relations and for linear, transversely hemitropic and transversely isotropic ones.

Spontaneous and Induced Symmetry-Breaking Bifurcations in the Equilibrating Orbits for Pseudo-Rigid Bodies

Researcher: Associate Professor John F. Pierce

The work examines what changes can occur to the orbit of trivially equilibrating configurations for a pseudo-rigid body possessing a natural state when perturbing loads are applied. The question is analyzed by formulating it as a problem of bifurcation on a group orbit to which the theory of singularities applies. The analysis indicates how alterations of the orbit depend upon features of the perturbing load and of the material composing the body.

Restricted Houseswapping Games

Researcher: Visiting Assistant Professor Thomas Quint

Restricted houseswapping games are a generalization of the class of houseswapping games (Shapley-Scarf 1974) where one specifies a class Π^* of "allowable" simple trading cycles. The cores of such games may be empty. If Π^* is "balanced," then all possible restricted houseswapping games have nonempty cores (no matter what individual preferences are.) The class of games for which Π^* is balanced includes all houseswapping (Shapley-Scarf) and also all marriage (Gale-Shapley, 1962) games.

The researcher then considers "restricted houseswapping games with money." Again the core may be empty in such games. Given Π^*, all possible restricted houseswapping games with money have nonempty cores if Π^* is "strongly balanced." Examples include Shapley and Shubik's assignment game (1972), Tijs et al's permutation game (1984), and Demange and Gale's labor marked (1985). This paper has been submitted to *Journal of Economic Theory*.

Sphere of Influence Graphs in Other Metrics

Researchers: Visiting Assistant Professor Thomas Quint and
Assistant Professor T. S. Michael

Suppose one is given a set of n points within any metric space. For point i, let N(i) be the point closest to i using the metric space's distance function, and let B(i) be the open hall with radius d(i,N(i)) around i. The sphere of influence graph is then the graph with n nodes, where arc y exists if $B(i) \cap B(j) \neq 0$. Sphere of influence graphs arise in fields such as computer science and fingerprinting.

The researchers investigate the following question: What sphere-of-influence graphs are possible given metric space N^d and distance function

$$d(x,y) = \left[\sum_{i=1}^{d} (x_i - y_i)^p \right]^{\frac{1}{p}}$$

for $p \geq 1$ and $d \geq 1$? Currently, the researchers are in the process of writing up the results.

Algebraic Structures Associated to Normed Bilinear Maps

Researcher: Associate Professor JoAnn S. Turisco

This work is a continuation of a previous project. The problem under consideration is that of determining necessary and sufficient conditions for the existence of normed bilinear maps. This is a well-known problem and has received considerable attention in recent years with notable progress made using the theory and tools of algebraic topology. This work involves a detailed study of Jordan algebras and triple systems which arise through these mappings, with the goal of solving the existence problem using purely algebraic methods.

Factoring Cyclotomic Polynomials with Matrices

Researcher: Professor William P. Wardlaw

In a previous paper ("Matrix Representation of Finite Fields") the author showed that the companion matrix of an irreducible factor of the cyclotomic polynomial $c_{q-1}(x)$ in $F_p[x]$, where $q = p^r$ with p prime, is a canonical cyclic generator of the field F_q. The researcher reverses this process starting with an irreducible polynomial of degree r (such that $q = p^r$), so that its companion matrix B generates F_q as an algebra over F_p. The researcher then locates a matrix A in $F_p[B]$ which is a cyclic generator of F_q. The characteristic polynomial of A is an irreducible factor of the cyclotomic polynomial $c_{q-1}(x)$. Moreover, for any divisor d of q - 1, the characteristic polynomial of $C = A^{(q-1)/d}$ is an irreducible factor of $c_d(x)$, and all of the irreducible factors of $c_d(x)$ can be found as the characteristic polynomials of C^k, where k is relatively prime to d.

The Fractal Transform

Researcher: Associate Professor William D. Withers

The researcher collaborated on improving the Fractal Transform method of image compression. Numerous enhancements were made to the basic Fractal Transform algorithm, with a cumulative effect of a dramatic improvement in the quality/compression-ratio/speed performance of the algorithm. Among the most important innovations were new pattern-matching algorithms which greatly improved compression speed; organization of fractal transform components to best exploit standard entropy-based data compression techniques; and variation of data density, which required the solution of associated optimization problems. The results from this project have been applied by the sponsor to the improvement of its line of image-compression hardware and software products.

The Fractal Coprocessor

Researcher: Associate Professor William D. Withers

The researcher collaborated on the design of the Fractal Coprocessor, a microchip which performs pattern matching as part of the Fractal Transform method of image compression. Special features of the chip include sixteen levels of parallelization, carefully implemented to avoid unnecessary duplication of data buffers; the ability to operate autonomously, so the main processor can continue other tasks while the chip is in operation; and doubling of input-output buffers, so that data can be loaded onto and off of the chip without interrupting operation. The chip contains 392,643 transistors, roughly comparable in size to an Intel 80386 microprocessor. The sponsor has developed a new generation of image compression hardware using the Fractal Coprocessor, which provides improved performance over its predecessor at a savings of approximately 90% in production cost.

Research Course Projects

Polynomials of Knots and Links

Researcher: Midshipman 1/C Norbert J. Karczewski III, USN
Adviser: Professor Mark E. Kidwell

The researcher learned the rudiments of knot and link theory. He was able to absorb the definition and some of the properties of the recently-discovered Jones polynomial. He spent the majority of his time learning about the classical Alexander polynomial.

In the case of the several-variable Alexander polynomial he was able to fill in some proofs that Alexander and Conway left undone.

Automated Track Reconstruction of a Non-Cooperative Target

Researchers: Midshipmen 1/C Brian C. Bender and
Michael D. Kozub, USN
Advisers: Professor W. Charles Mylander and Dr. Daniel Wagner

The submarine force desires the capability to reconstruct the track of a simulated target after an engagement. In many cases the target is unwilling or unable to supply information about its track. The track must be reconstructed using information passively gathered by the submarine during the engagement. This project had as its goal the development of prototype software leading to code that will run on a computer carried aboard submarines. A Turbo Pascal program was developed for the task. It uses an unconstrained minimization technique, the Quasi-Newton Method, to minimize the sum of the squared deviations between observed bearings to the target and the bearings to the target implied by the conjectured target track. The target's track is iteratively modified to minimize the sum of the squared residuals. Limited testing indicates the program works very well.

Nullity Patterns of Bisymmetric Matrices

Researcher: Midshipman 1/C Kristen W. Culler, USN
Adviser: Professor Geoffrey L. Price

As part of her mathematics honors project, the researcher succeeded in doing some original research on a combinatorial problem in matrix theory which generalized a portion of her faculty adviser's recent work in the field of operator algebras. Using a bitstream sequence consisting of elements in a finite field, one may form an n by n matrix A_n for each n which is skew-symmetric with respect to the main diagonal, symmetric with respect to the secondary diagonal, and which depends upon the first n elements of the bitstream. The researcher discovered some patterns related to computing the nullity of these matrices, which were subsequently applied to count the number of n by n matrices of this type which are invertible. The work will be submitted for publication.

Analysis of Personnel Flow Through a Ship

Researcher: Midshipman 1/C R. Scott Thomas
Adviser: Professor Thomas J. Sanders

The Naval Sea Systems Command (NAVSEA) General Arrangement Design division is responsible for the design and configuration management of a ship's general arrangement and habitability outfitting. One of their most important tasks is to ensure adequate personnel access throughout a new ship design. They currently use a simulation tool for analyzing the problem of personnel flow in a ship in the design phase. This tool, named PERSFLO, was written in FORTRAN and was developed in the 1970's. They are currently replacing PERSFLO for three reasons: (1) The program is not integrated with their modeling capabilities this means that preparing the input necessary to run the program is a manual and time-consuming process; (2) The program was custom written for NAVSEA and must be maintained by them; and (3) The program interface is not user-friendly and gives non-graphical results that are tedious to interpret.

The purpose of this project was to analyze the capabilities of ProModelPC (a modern simulation tool), to determine if it could be used to study the personnel flow of a ship and to determine the inputs that would be needed if NAVSEA decided to use it.

The ProModel/PC software was easy to learn and

use. A problem encountered was the large amounts of typing needed to put the ship model into the simulation tool. This problem may be reduced to a manageable size by writing code that interprets information in an existing database. It is also necessary for the user to input the routing logic into the model. This involves deciding which passage a person would choose at each intersection, based on knowledge of the person's final destination and seems to require the user to individually do each node.

NAVSEA is currently in the process of purchasing a copy of ProModel for Windows that, based on the results of this research, they expect to be able to use to model the personnel flow through a ship that is under development.

A Comparison of Computer Arithmetics

Researcher: Midshipman 1/C Scott D. McClellan
Adviser: Associate Professor Peter R. Turner

This project involves the study and software implementation of three computer arithmetic systems: the floating point system as it is used in many computer systems and extensions of this system due to Matsui and Iri and Hamada.

The floating point system is the standard real arithmetic of scientific computing but suffers from real restrictions due to its limited range and fixed relative precision. The extensions considered here both use variable length exponents and mantissas in order to extend the range of numbers that can be represented in a fixed wordlength. This also results in a variable mantissa length and consequently variable relative precision in the representation.

For a single precision (32-bit) word too much of the word must be used for the "pointer" which indicates the length of the exponent to make the representation practically realistic but it still allows the representation to be simulated and its basic properties to be studied. The precision for numbers close to unity is enhanced while at the extremes of the range it is substantially reduced relative to standard (IEEE) floating-point. The variable length exponent and much greater range imply that arithmetic with the extended systems is significantly more complicated with much greater alignment shifts being needed before arithmetic can be performed.

Publications

BEEL, Joseph J., Lieutenant, USN, "Rockets for Navy Helicopters", *Rotor Review*, 40 (Winter 1993), 37-39.

Rockets For Navy Helicopters-How Navy helicopters will be armed is still a very important issue. The armament for these helicopters must be chosen carefully to maximize their capability in a wide range of missions while maintaining cost effectiveness. The Navy will be expected to respond to world crises with smaller forces and less equipment. Arming U.S. Navy helicopters can contribute significantly to mission effectiveness in this environment. Naval helicopter missions in crisis and limited objective warfare situations may often be accomplished with less force than an anti-surface missile. Naval helicopters should be armed with a mix of weapons which allows flexible, cost effective response in a wide variety of situations. Improved range and lethality make hypervelocity rockets more appropriate for use by naval helicopters than conventional 2.75 inch rockets. It may also be suitable for naval applications similar to those that the Army is examining. Arming naval helicopters with 2.75 inch rockets, hypervelocity and conventional, will significantly increase the Navy's offensive and defensive power.

CRAWFORD, Carol G., Associate Professor, co-author "Graph Matching and Image Processing Neural Networks for Fingerprint Identification," Technical Report for The Federal Bureau of Investigation, September 1992, 1-14.
This technical report includes results of the second

year of an ongoing co-operative project in Automated Fingerprint Identification with the Center for Theoretical and Applied Neural Science at Yale University. Sponsored by The Federal Bureau of Investigation, this work presents some innovative methods for image processing, matching and classification of fingerprints. In addition to presenting theoretical developments, the authors also include software implementations of their results.

HERRMANN, Robert A., Professor, "Scientific premises? "*CRS Quarterly*, 3 (1992), 160-161.

In this paper, the basic MA-model conclusion that establishes that there are infinitely many describable scenarios for how our universe may have come into being, how life began on earth and how the solar system was formed is applied to the so-called scientific premises that form the foundational axioms for modern cosmology. It is shown that these axioms can have no scientific truth value and are selected only to alter an individuals belief-system.

KAMMEYER, Janet W., Associate Professor, "A Classification of the Finite Extensions of a Multidimensional Bernoulli Shift,"
Transactions of the American Mathematical Society, 335, 1 (January 1993), 443-447.

The finite extensions of a multidimensional Bernoulli shift are classified completely, up to factor isomorphism, and up to isomorphism. If such an extension is weakly mixing then it must be Bernoulli; otherwise, it has a finite rotation factor, which has a Bernoulli complementary algebra. This result is extended to multidimensional Bernoulli flows and Bernoulli shifts of infinite entropy.

KAMMEYER, Janet W., Associate Professor, "A Classification of the Isometric Extensions of a Multidimensional Bernoulli Shift,"
Ergodic Theory and Dynamical Systems, 12 (1992), 267-282.

The isometric extensions of a multidimensional Bernoulli shift are classified completely, up to C-isomorphism, and up to isomorphism. If such an extension is weakly mixing then it must be Bernoulli; otherwise, it has a rotation factor, which has a Bernoulli complementary algebra. This result is extended to multidimensional Bernoulli flows and Bernoulli shifts of infinite entropy.

KIDWELL, Mark, Professor, Review of "Not Knot" video, *College Mathematics Journal*, 24, 2 (March 1993) 197-198.

This is a review of the film "Not Knot" which was put out by the Minnesota Geometry Project. The film discusses the work of William Thurston on the connection between the complements of knots and hyperbolic geometry.

KONKOWSKI, Deborah A., Associate Professor, co author, "Stability Analysis of a Nonscalar Curvature Singularity," *Physics Review* D46 (August 1992), 1424-1428.

The behavior of test scalar waves on a dust-filled type-V locally rotationally symmetric spacetimes is used to probe the nonscalar curvature singularity present and its associated Cauchy horizon. It is argued that the divergence of the stress-energy scalars for most wave modes makes the nonscalar curvature singularity unstable in general. However, a special subset of modes does not lead to divergence of the stress-energy scalars at the nonscalar singularity. These modes would leave the nonscalar curvature singularity unchanged. Furthermore, examination of the stress-energy tensor in a parallel-propagated orthonormal frame and stress-energy scalars show that the Cauchy horizon is left unchanged.

KONKOWSKI, Deborah A., Associate Professor, co-author, "Singularities in Colliding Plane-Wave Spacetimes," *Proceedings* of the 4th Canadian Conference on General Relativity and Relativistic Astrophysics, Singapore: World Scientific, 1992, pp. 115-119.

Singularities in colliding plane-wave spacetimes are studied. Colliding impulsive gravitational plane-wave spacetimes and colliding sandwich gravitational plane-wave spacetimes are shown to possess quasiregular singularities while colliding thick gravitational plane-wave spacetimes have nonscalar curvature singularities. It is argued that these singularities are generally unstable. Scalar and electromagnetic wave perturbations support this result. However, a special subset of electromagnetic modes does not lead us to predict a scalar curvature singularity. A quasiregular singularity is predicted instead, and it is confirmed in the colliding gravitational and electromagnetic-wave spacetimes of Chandaeskhar and Xanthropolos.

MATHEMATICS

KONKOWSKI, Deborah A., Associate Professor, co-author, "Testing a stability conjecture for Cauchy horizons", *Physics Review*, D15 (1993) 4322-4327.

A stability conjecture previously developed to investigate quasiregular and nonscalar curvature singularities is extended here to cover the stability of Cauchy horizons. In particular, the Reissner-Nordstrom space time of charged, nonrotating black holes is considered. The conjecture predicts that the addition of infalling null dust with a power-law tail will produce a nonscalar curvature singularity at the Cauchy horizon. This prediction is verified using a Reissner-Nordstrom-Vaidya spacetime studied by Hiscock. The conjecture also predicts that a combination of infalling and outgoing null dust will produce a scalar curvature singularity at the Cauchy horizon. This prediction is verified using the mass inflation results of Poisson and Israel. Finally, the conjecture predicts that the addition of infalling scalar or electromagnetic waves will produce a scalar curvature singularity at the Cauchy horizon.

LOCKHART, Jody Meyer, Associate Professor, "The Conjugacy Problem for Graph Products with Finite Cyclic Edge Groups," *Proceedings* of the American Mathematical Society, 117 (1993), 897-898.

Finite graph products of groups with solvable conjugacy problem and with finite cyclic edge groups are considered. K.J. Horadam showed that finite graph products with finite cyclic edge groups inherit a solvable conjugacy problem from their vertex groups under certain conditions, one of which is that the images of the edge group generators in each vertex group are powers of a common central element. In this paper, it is shown that this condition is not necessary and, in fact, that all finite graph products with finite cyclic edge groups inherit a solvable conjugacy problem from their vertex groups. The result is first proved for HNN-extensions and free products with amalgamation and then extended to graph products by induction.

MCCOY, Peter A., Professor, "Polynomial Expansions of Analytic Functions by Function Theoretic Methods," *Partial Differential Equations with Complex Analysis*, Pitman Research Notes in Mathematics Series, eds. H. Begehr & A. Jeffrey, 262 (1993), 122-133.

Z. Nehari's classical theorem locates the singularities of Legendre expansion in terms of the singularities of an associated analytic function of one complex variable. This article establishes a general version of Nehari's result. The Legendre series is replaced by an Appell polynomial expansion which includes Nehari's result and many of the solutions to the equations of mathematical physics.

MCCOY, Peter A., Professor, "Solutions of the Helmholtz equation Having Rapid Growth," *Complex Variables*, 18 (1992), 91-101.

Function Theoretic Methods characterize the growth of entire function solutions of the Helmholtz equation on R^2. Solutions of infinite order and type are identified through coefficient and Bernstein approximation theorems.

MEYERSON, Mark D., Professor, "Conformal Mapping and Fracture Mechanics," *Engineering Fracture Mechanics*, 41 (1992), 951-953.

The purpose of this article is to apply conformal mapping methods to a particular problem in fracture mechanics. One procedure for analyzing fracture properties of metal involves a rectangular piece of a metal sample with a notch cut out of it. The sample is subjected to carefully measured, repeated stress until it cracks at the base of the notch. The size of the crack and stress history provide useful information about the strength properties of the metal used. One difficulty in this procedure is that the crack can be very difficult to see and to measure. An attempt has been made to measure the length of this crack by measuring the change in the resistance of electricity flowing from one part of the metal sample to another. Here, we look at a mathematical model of this electrical resistance, and use a computer package called SCPACK [5], by Lloyd Trefethen, to analyze how the resistance should change with the length of the crack.

MICHAEL, T.S., Assistant Professor, "The structure matrix of the class of r-multigraphs with a prescribed degree sequence," *Linear Algebra Applics*, 183 (1993), 155-177.

We introduce a structure matrix into the study of the class of multigraphs with a prescribed degree sequence D. With the structure matrix we obtain

necessary and sufficient conditions for the existence of a graph with degree sequence D. We also provide a formula for the maximum size of a matching among all graphs with degree sequence D.

MOEN, Courtney, Associate Professor, "The dual Pair (U(1),U(1)) over a p-adic field," *Pacific Journal of Mathematics*, 158, 2 (1993), 365-386.

We find an explicit decomposition for the metaplectic representation restricted to either member of the dual reductive pair (U(1),U(1)) in $\tilde{S}L$ (2,F), where F is a p-adic field, with p odd.

PENN, Howard Lewis, Professor, *Instructor's Resource Guide to Zill's Calculus 3rd Edition Using Mathematics Plotting Package MPP*, Boston, Massachusetts: PWS-Kent Publishing Company 1992.

This 250 page supplement presents examples and exercises tied to Zill's Calculus, 3rd Edition using MPP, the Calculus Program written at the Naval Academy. the book includes computer disks containing a large number of example files that are tied directly to examples in the supplement. Most of these examples are directly related to materials present in the Calculus Text Book. Many other applications are covered that cannot be present well without the use of a computer program.

PRICE, Geoffrey L., Professor, co-author, "Binary Shifts on the Hyperfinite II_1 Factor," *American Mathematical Society Contemporary Mathematics Series*, 145 (1993), 453-464.

A shift on a unital C^*-algebra A is a *-endomorphism σ of A which fixes the identity and has the property that the intersection of the ranges of its powers σ^n consists only of scalar multiples of the identity. This paper considers shifts on the hyperfinite II_1 factor R. Using Connes' classification of the outer conjugacy classes of the group of automorphisms of R as a motivation, the authors consider outer conjugacy invariants for a class of shifts called binary shifts. Binary shifts are non-commutative analogues of Bernoulli shifts. The construction of these shifts is also related to some constructions used in signal analysis. Although binary shifts form a rather restricted class of *-endomorphisms, their

structure is quite rich. This paper demonstrates a connection between outer conjugacy classes and Bratteli diagrams of inductive limits of finite-dimensional algebras associated with binary shifts.

TURNER, Peter R., Associate Professor, co-author, *Numerical Methods and Analysis, Instructor Manual*. Hightstown, New Jersey: McGraw Hill, 1993.

This is the Instructor's Solution manual to accompany the author's textbook Numerical Methods and Analysis which is a senior level undergraduate of first graduate text in Numerical analysis with its emphasis clearly rooted in practical applications. The desire to develop good numerical routines for solving problems drives the mathematical development rather than the other way around but the methods presented are analyzed fully. Coverage includes computer arithmetic and errors, iterative solution of nonlinear equations, evaluation of elementary functions, interpolation, approximation and curve-fitting (including splines, Bezier curves and Fast Fourier Transform), linear systems of equations, optimization, numerical integration, numerical solution of differential equations, boundary value problems, eigenvalues and an introduction to the ideas of parallel processing. The instructor manual is accompanied by a software diskette containing Turbo Pascal units implementing the algorithms discussed in the text.

TURNER, Peter R., Associate Professor, co-author, "Symmetric Level Index Arithmetic in Simulation and Modeling," *NIST Journal of Research*, 97 (1992), 471-485.

This paper begins with a general introduction to the symmetric level-index, SLI, system of number representation and arithmetic. This system provides a robust framework in which experimental computation can be performed without risk of failure due to overflow/underflow or to poor scaling of the original problem. There follows a brief summary of some existing computational experience with this system to illustrate its strengths in numerical, graphical, and parallel computational settings. An example of the use of SLI arithmetic to overcome graphics failure in the modeling of a turbulent combustion problem is presented. The main thrust of this paper is to introduce the idea of SLI-linear least squares data-fitting. The use of generalized

logarithm and exponential functions is seen to offer significant improvement over the more conventional linear regression tools for fitting data from a compound exponential decay such as the decay of radioactive materials.

TURNER, Peter R., Associate Professor, "A History of the Lords of Number-Crunching," *American Math Monthly*, 99 (1992), 907-916 and cover.

This brief "history" provides the reader with a simple introduction to the ideas of level-index arithmetic by tracing, via an allegorical development of a mythical village, the development of computer arithmetic from "the dark ages" of fixed-point arithmetic system through the floating-point system and its shortcomings to the future world of "level-index man." The article is suitable for a general scientific audience. It is accompanied by a "map" of the village which is to be used as a cover illustration for the appropriate issue of the journal.

TURNER, Peter R., Associate Professor, co-author, "Robust parallel computation in Floating-point and SLI arithmetic," *Computing*, 48, (1992), 239-257.

In this paper, we consider the parallel computation of vector norms and inner products in floating-point and a proposed new form of computer arithmetic, the symmetric level-index, SLI, system. The vector norms provide an illuminating example of the contrast between these systems in terms of robustness and parallelizability. The conflict between robustness (accuracy and freedom from overflow/underflow) and parallelization for floating-point systems is made plain. This conflict is eliminated by the use of the SLI system. The freedom from overflow and underflow offered by this system allows much simpler programming for many problems. Numerical results are included to illustrate the facts that SLI yields comparable results with those of floating-point when the latter system works and still yields results of high accuracy even when the floating-point system fails completely.

TURNER, Peter R., Associate Professor, "Complex SLI Arithmetic: Representation, Algorithms and Analysis," *Proceedings* of the 11th IEEE Symposium on Computer Arithmetic,

Society, Washington DC, July 1993, pp. 18-25.

In this paper the extension of the SLI system to complex arithmetic is discussed. The natural form for representation of complex SLI quantities is in modulus-argument form and this can be sensibly packed into a single 64-bit word for the equivalent of the 32-bit real SLI representation. The arithmetic algorithms prove to be very little more complicated than for real SLI arithmetic. The paper describes the representation, arithmetic algorithms and the control of error within these algorithms.

TURNER, Peter R., Associate Professor, co-author, "Adaptive beamforming using RNS arithmetic," *Proceedings* of the *11th IEEE Symposium on Computer Arithmetic*, IEEE Computer Society, Washington DC, July 1993, pp. 36-43.

This paper is concerned with the solution of the adaptive beamforming problem using an algorithm-architecture-arithmetic combination which has the potential for use on a small platform such as aircraft or sonobuoys. The arithmetic used is the RNS system implemented on an array of processors which can be reassigned as the algorithm proceeds. The underlying algorithm is a modified Gauss elimination. The (non RSN) division operations are eliminated in favor of some scaling and the adaptive use of the processor array to accommodate the growth in the dynamic range.

TURNER, Peter R., Associate Professor, co-author, "Symmetric Level Index Arithmetic in Simulation and Modeling," *Modeling and Simulation*, 23, 1 (1992), 407-417.

This paper begins with a general introduction to the symmetric level-index, SLI, system of number representation and arithmetic. This system provides a robust framework in which experimental computation can be performed without risk of failure due to overflow-underflow or to poor scaling of the original problem. There follows a brief summary of some existing computational experience with this system to illustrate its strengths in numerical, graphical, and parallel computational settings. An example of the use of SLI arithmetic to overcome graphics failure in the modeling of a turbulent combustion problem is presented. The main thrust of this

paper is to introduce the idea of SLI-linear least squares data-fitting. The use of generalized logarithm and exponential functions is seen to offer significant improvement over the more conventional linear regression tools for fitting data from a compound exponential decay such as the decay of radioactive materials.

WARDLAW, William P., Professor, co-author, "A hypergeometric formulation of Fermat's Last Theorem," *International Journal of Mathematical Educational Science Technology*, 23, 2, (1992), 235-238.

Solutions of Fernat's last equation are expressed in terms of Wright's generalized hypergeometric function. Some of the properties of these solutions are discussed and an equivalent form of Fermat's conjecture is given in terms of them.

WARDLAW, William P., Professor,"Euler's Theorem for Polynomials," *Mathematics Magazine*, 65, 5 (December 1992), 334-335.

The similarity of the arithmetic of the integers and the arithmetic of polynomials suggests that an analog of Euler's Totient Theorem for integers also holds for polynomials over a finite field. This theorem is stated and proved, and then some applications to factoring polynomials over finite fields are mentioned.

WARDLAW, William P., Professor, "Problem 1419," *Mathematics Magazine*, 65 (April), 126.

Show that for each prime p, there is an integer g such that $1<g<p$ and g is a primitive root modulo p^n for every positive integer n.

WARDLAW, William P., Professor, "Problem 10301," *American Mathematical Monthly*, 100, 4 (April), 401.

Let R be a commutative ring with identity. For which matrices A in GL_n (R) is the mapping.

$$\alpha_a{:}SL_n(R){\rightarrow}SL_n(R) \text{ defined by } X \rightarrow AXA\text{-}1$$

an *inner* automorphism of SL_n (R).

WITHERS, Wm. Douglas, Associate Professor, "Differentiability With Respect to Parameters of Average Values in Probabilistic Contracting Dynamical Systems," *Ergodic Theory and Dynamical Systems*, 10 (1990), 599-610.

We consider a dynamical system consisting of a subset X of R^N or C^N with several contracting maps chosen with prescribed probabilities, which may depend on position. We show that if the maps and the probabilities are $C^{1+\alpha}$ functions of the spatial variable and an external parameter, then the average value of a $C^{1+\alpha}$ function is a differentiable function of the parameter. One implication of this theorem is that for certain families of complex functions dependent on a parameter the reciprocal of the dimension of an invariant measure on the Julia set is a harmonic function of the parameter.

WITHERS, Wm. Douglas, Associate Professor, co-author, "Weight-balanced Measures and Free Energy for One-dimensional Dynamics," *Forum Mathematicum*, 5 (1993), 161-182.

In this paper thermodynamic-formalism properties of one-dimensional maps are considered. The researchers consider the existence of weight-balanced measures a large-deviation properties of the free energy of the Jacobian of measures. The researchers show that a weight-balanced measure exists under the hypotheses that the map is piecewise-homomorphic and the weights piecewise constant. Also considered is a certain class of measures with the property that the free energy of the Jacobian is piecewise-differentiable. For measures in this class it is shown that a certain measure is the maximal-entropy measure if and only if the free energy of the Jacobian is linear. This is proved using methods of large-deviation theory and does not use the more classical approach of thermodynamic formalism.

Presentations

BAILEY, Craig K., Associate Professor, "Josephus Permutations - Field for Undergraduate Research." Washington and Lee University Math Colloquium, Lexington Virginia, 9 November 1992.

BAILEY, Craig K., Associate Professor, "Basketball and Banana Splits," Banneker Program, Annapolis, Maryland, 27 March 1993.

BAKER, B. Mitchell, Associate Professor, "A Dynamical Systems Approach to Cardiac Arrhythmias," Applied Mathematics Seminar, Annapolis, Maryland, 20 October 1992.

BEEL, Joseph J., Lieutenant, USN, "Hypervelocity Rocket Lethality Models," Military Operations Research Society Symposium, Monterey, California, 23 June 1992.

BEEL, Joseph J., Lieutenant, USN, "Hypervelocity Rocket Lethality Models," Association for Unmanned Vehicle Systems Symposium, Huntsville, Alabama, 21 June 1992.

BUCHANAN, James L., Professor, "Constitutive Equations for a Hypermembrane Shell," Society of Industrial and Applied Mathematicians Annual Meeting, Los Angeles, California, 23 July 1992.

CRAWFORD, Carol G., Associate Professor, "Graph Matching and Image Processing Neural Networks for Fingerprint Identification," Yale University Computer Science Department, New Haven, Connecticut, 17 August 1992.

CRAWFORD, Carol G., Associate Professor, "Graph Matching and Neural Networks for Fingerprint Identification," Applied Mathematics Seminar, Annapolis, Maryla: J, 26 October 1992.

GAGLIONE, Anthony M., Professor, "The Model Theory of Free Groups," Fall Topology & Combinatorial Group Theory Conference, Albany, New York, 16 October 1992.

GAGLIONE, Anthony M., Professor, "Some Questions on n-Free Groups and their Model Theory," New York Group Theory Seminar, 4

December 1992.

GAGLIONE, Anthony M., Professor, "Generalizations of Free Groups," Applied Mathematics Seminar, Annapolis, Maryland, 28 April 1993.

GAGLIONE, Anthony M., Professor, "What is the Probability that Two Elements of a Group Commute?" Applied Mathematics Seminar, Annapolis, Maryland, 19 April 1993.

GAGLIONE, Anthony M., Professor, "Generalization of Free Groups, Some Questions," Ohio-Denison Group Theory Conference, Binghamton, New York, 22 May 1993.

GARCIA, Sonia M. F., Assistant Professor, "On the Mixed Finite Element Methods for Parabolic Problems," Finite Element Meeting, Purdue University, West Lafayette, Indiana, 15-19 July 1992.

GARCIA, Sonia M. F., Assistant Professor, "Development of a Numerical Method for Solving the Nonlinear Parabolic System Describing the Formation of Wing Cracks in Ice," Applied Mathematics Seminar, Annapolis, Maryland, 15 September 1992.

GARCIA, Sonia M. F., Assistant Professor, "Improved Error Estimates for Mixed Finite Element Approximations for Nonlinear Parabolic Equations: the Continuous Case", University of Cincinnati, Cincinnati, Ohio, 11-14 March 1993.

GRANT, Caroline G., Assistant Professor, "Complete Kahler Metrics for Singular Algebraic Varieties," University of Toronto seminar, Toronto, Canada, 29 June 1993.

GRANT, Caroline G., Assistant Professor, "Metrics for Singular Analytic Spaces," American Mathematical Society Meeting, Washington, DC, 17 April 1993.

GRANT, Caroline G., Assistant Professor, "Macaulay: A Computer System for Algebraic Geometry," USNA Mathematics Colloquium,

Annapolis, Maryland, 28 April 1993.

HERRMANN, Robert A., Professor, "A corrected Derivation for the Special Theory of Relativity," Maryland, District of Columbia, Virginia Section of the Mathematical Association of American Fall Meeting, Coppin State University, Baltimore, Maryland, 14 November 1992.

HOFFMAN, Michael, Associate Professor, "Group Actions, Cohomology Representations and the Lefschetz Fixed Point Theorem," Joint Summer Research Conference on Cohomology, Representations, and Actions of Finite Groups, South Hadley, Massachusetts, 24 June 1992.

KAMMEYER, Janet W., Associate Professor, "Restricted Orbit Equivalence for Ergodic Z^d -- actions," George Mason University Mathematics Department Colloquium, Fairfax, Virginia, 6 November 1992.

KAMMEYER, Janet W., Associate Professor, "Restricted Orbit Equivalence for Ergodic Z^d Actions I," AMS Special Session in Ergodic Theory, Dynamical Systems and Applications, Howard University, Washington, DC, 17 April 1993.

KAPLAN, Harold M., Professor, "A Short Quick Program to do Least-Squares Polynomial Regression with Cross-Validation," Mid-Atlantic Regional Probability and Statistics Day, The Johns Hopkins University Applied Physics Laboratory, Laurel, Maryland, 24 October 1992.

KIDWELL, Mark E., Professor, "Fibered Knots via Graph Theory," USNA Math Colloquium, Annapolis, Maryland, 14 April 1993 and University of Maryland Baltimore County, Math Colloquium, Catonsville, Maryland, 7 May 1993.

KONKOWSKI, Deborah A., Associate Professor, "Stability of Non-Scalar Curvature Singularities," Cosmic Censorship Workshop, Aspen Center for Physics, Aspen, Colorado, 18 June 1992.

KONKOWSKI, Deborah A., Associate Professor, "Stability of Non-Scalar Curvature Singularities," Thirteenth International Conference on General Relativity and Gravitation, Huerta Grande, Argentina, 2 July 1992.

KONKOWSKI, Deborah A., Associate Professor,

"Testing a Stability Conjecture for Cauchy Horizons," Texas/PASCOS Conference, Berkeley, California, 15 December 1992.

KONKOWSKI, Deborah A. Associate Professor, "Cosmic Strings," Colloquium Talk, University of Waterloo, Ontario, Canada, 11 March 1993.

KONKOWSKI Deborah A. Associate Professor, "Singularities in Colliding Plane Wave Spacetimes," Relativity Theory Seminar Talk, University of Waterloo, Ontario, Canada, 12 March 1993.

KONKOWSKI, Deborah A. Associate Professor, "Testing a Stability Conjecture for Cauchy Horizons," Fifth Canadian Conference on General Relativity and Relativistic Astrophysics, Waterloo, Canada, 14 May 1993.

MALEK-MADANI, Reza, Professor, "Some Stability Theorems in Thermo-Visco-elasticity", Colloquium, University of Pisa, Italy, and University of Padua, Italy, 10 June 1992.

MALEK-MADANI, Reza, Professor, "State-of-Art Lecture of the Mathematical Science Division of the Office of Naval Research," Washington, DC, 17 March 1993.

MCCOY, Peter A., Professor, "Near-Circularity of the Error Curve and Optimal Approximation of Solutions to a Class of Elliptic PDE'S in the Complex Plane," SIAM 40th annual meeting, Los Angeles, California, 23 July 1992.

MCCOY, Peter A., Professor, "Recent Advances in Signal Processing," USNA Mathematics Department Colloquium, Annapolis, Maryland, 28 October 1992.

MCCOY, Peter A., Professor, "151 Years of Sampling Theory," Mathematical Association of American, MD-DC-VA Sectional Meeting, Coppin State University, Baltimore, Maryland, 14 November 1992.

MCCOY, Peter A., Professor, "Sampling Theorems Associated with Boundary Value Problems for Elliptic Partial Differential Equation's in R^N," American Mathematical Society, 99th annual meeting, San Antonio, Texas, 13 January 1993 (Co-Chair Session on Partial Differential Equations).

MCCOY, Peter A., Professor, "Imaging Techniques by X-Ray Absorption Methods," USNA Mathematics Department Colloquium, Annapolis, Maryland, 17 March 1993.

MCCOY, Peter A., Professor, "An Introduction to Tomography," Mathematical Association of America, MD-DC-VA Sectional Meeting, Christopher Newport University, Newport News, Virginia, 17 April 1993.

MICHAEL, T.S., Assistant Professor, "Ryser Inequalities," Combinatorics Seminar at The George Washington University, Washington, DC, 13 November 1992.

MICHAEL, T.S., Assistant Professor, "Sphere of Influence Graphs," Combinatorcs Seminar at The George Washington University, Washington, DC, 26 March 1993.

MICHAEL, T.S., Assistant Professor, "Beyond the Pigeon-Hole Principle: A Gentle Introduction to Ramsey Theory," USNA Mathematics Department Colloquium, Annapolis, Maryland, 31 March 1993.

NAKOS, George, Associate Professor "Introduction to Mathematica," United States Naval Academy, High School recruiting program, Annapolis, Maryland, 8 June 1992.

PENN, Howard L., Professor, "Visualization of Applications of Calculus and Differential Equations," International Congress on Mathematics Education, Quebec City, Quebec, 10 August 1992.

PENN, Howard L., Professor, Visualization of Applications of Calculus and Differential Equations," Mathematical Association of America National Meeting, San Antonio, Texas, 7 January 1993.

PIERCE, John F., Associate Professor, "Extracting Topographical Roughness Information from SAR Data from the Magellan Spacecraft," ASEE/NASA Goddard Summer Research Program, Greenbelt, Maryland, 6 July 1992.

PRICE, Geoffrey L., Professor, "Shifts on the Hyperfinite II₁ Factor," American Mathematical Society Regional Meeting, Dayton, Ohio, 30 October 1993.

QUINT, Thomas, Assistant Professor, "The Shapley Value of Resale-Proof Trades," International Conference on Game Theory, SUNY Stony Brook, New York, 15 July 1992.

QUINT, Thomas, Assistant Professor, "Restricted Houseswapping Games," USNA Mathematics Department Colloquium, Annapolis, Maryland, 14 October 1992.

QUINT, Thomas, Assistant Professor, "Restricted Houseswapping Games," Midwestern Mathematical Economics Conference, University of Pittsburgh Pennsylvania, 21 October 1992.

QUINT, Thomas, Assistant Professor, "Lattices and Two-Sided Matching Markets," Virginia Commonwealth University Department of Economics Seminar, Richmond, Virginia, 18 February 1993.

STUCKER, Aaron I., Assistant Professor, "An Algebraic Approach to Equivariant Whitehead Torsion for Compact Lie Groups," Annual Mathematics Meeting, San Antonio, Texas, 16 January 1993.

TURNER, Peter R., Associate Professor, "Overflow and Underflow: Causes and Effects," Naval Air Warfare Center-AD, Warminster, Pennsylvania, 8 June 1992.

TURNER, Peter R., Associate Professor, "Overflow and Underflow: A Remedy," Naval Air Warfare Center-AD, Warminster, Pennsylvania, 9 June 1992.

TURNER, Peter R., Associate Professor, "Symmetric Level-Index Arithmetic: An Environment for Data Fitting," SIAM National Meeting, Los Angeles, California, 8 July 1992.

TURNER, Peter R., Associate Professor, "Elementary Number Theory CAN Be Useful!", USNA Mathematics Department Colloquium, Annapolis, Maryland, 13 October 1992.

TURNER, Peter R., Associate Professor, "Complex SLI Arithmetic: Algorithms and Error Control," USNA Applied Math Seminar, Annapolis, Maryland, 3 November 1992.

TURNER, Peter R., Associate Professor, Complex SLI Arithmetic: Representation,

Algorithms and Analysis," ARITH 11, Windsor, Ontario, 16 June 1993.

TURNER, Peter R., Associate Professor, co-author, "Adaptive Beamforming using RNS Arithmetic," ARITH 11, Windsor, Ontario, 17 June 1993.

TURNER, Peter R., Associate Professor, "Complex SLI Arithmetic," SIAM National Meeting, Philadelphia, Pennsylvania, 14 July 1993.

TURNER, Peter R., Associate Professor, co-author, "Adaptive Beamforming Using RNS Arithmetic," SIAM National Meeting, Philadelphia, Pennsylvania, 15 July 1993.

WARDLAW, William P., Professor, "Minimum and Characteristic Polynomials of Low-Rank Matrices," Annual Meeting of the American Mathematical Society and the Mathematical Association of America, San Antonio, Texas, 13 January 1993.

WARDLAW, William P., Professor, "Factoring Cyclotomic Polynomials with Matrices," MD-DC-VA Section of the Mathematical Association of America spring meeting, Christopher Newport University, Newport News, Virginia,

17 April 1993.

WARDLAW, William P., Professor, "The RSA Public Key Cryptosystem," Thomas Jefferson High School of Science and Technology annual Mathematics Day program, Fairfax County, Virginia, 21 April 1993.

WARDLAW, William P., Professor, "Factoring Cyclotomic Polynomials with Matrices," USNA Mathematics Department Colloquium, Annapolis, Maryland, 5 May 1993.

WITHERS, Wm. Douglas, Associate Professor, "An Introduction to Iterated Function Systems," Fracture, Form, and Fractals U.S.-Japan Joint Workshop, Lake Arrowhead, California, 25 September 1989.

WITHERS, Wm. Douglas, Associate Professor, "Fractals," Goddard Space Flight Center Engineering Colloquium, Greenbelt, Maryland, 28 October 1991.

WITHERS, Wm. Douglas, Associate Professor, "Color," USNA Mathematics Department Colloquium, Annapolis, Maryland, 3 November 1991.

Oceanography

Captain Carl B. Ihli, Jr., USN
Chair

Academic year 1992-1993 was particularly productive in terms of US Naval Academy oceanographic and meteorological research. The Oceanography Department research philosophy is guided by two baseline themes: (1) maximize midshipmen involvement, while (2) employing "total quality" techniques. The faculty accomplished some very significant successes with respect to these principles.

Nineteen students participated in the fourth summer research cruise aboard the Naval Academy's oceanographic platform, YP686. More than one-hundred oceanographic stations were completed in this four week endeavor; physical biological, chemical, meteorological, and geologic data were collected and processed; state-of-the-art equipment and techniques were employed, as were classical but effective methods and tools.

Twenty three midshipmen were involved in direct, "hands-on" research through enrollment in the Department Independent Reseach courses. These research projects, directed by both civilian and military faculty, introduced the students to the excitement and responsibility of data collection and analysis. Our midshipmen invariably commented on the invaluable learning experience that this exposure to the scientific method represents for them. During formal presentations of their research, at the end of each semester, these young investigators come together and share the results of their efforts and experiences with the Faculty and Senior Administrators.

As a result of the Department's Independent Research program, five midshipmen went on to deliver oral and poster presentations at professional conferences of the American Geophysical Union and Oceanography Society.

Our Faculty continue to be actively involved in scientific and scholarly endeavors, without losing sight of the need to have at their disposal the latest technologically advanced instrumentation and methodology.

Sponsored Research

Acquisition and Manipulation of Side-Scan SONAR Data in the Chesapeake Bay and Vicinity

Researcher: Associate Professor Peter L. Guth
Sponsor: Naval Research Laboratory

Using the department's new side scan sonar and YP686, the researcher is looking at bedforms and bottom features in the Chesapeake Bay near Annapolis. During the summer cruise the area of operations will be extended to the Delaware Bay and the continental shelf. The researcher will validate the side scan data with bottom sample grabs and through use of a remotely operated vehicle with video camera. The researcher will look at ways to manipulate and display the results and consider how to incorporate them into the academic program. The program is currently in the planning stage.

Measured and Modeled Scattering Anisotropy of Clear Skies

Researcher: Visiting Professor Raymond L. Lee, Jr.
Sponsor: Naval Oceanography Command

To the uninitiated, the clear daytime sky seems such a commonplace that its radiance distribution must surely be well known. Researchers in fields ranging from solar energy engineering to atmospheric optics have repeatedly measured and modeled the angular distribution of clear-sky radiances, and they have published a score of papers on the subject. What can be left to know? As this study demonstrates, a great deal is left to know. All previous models of clear-sky radiances have been judged using measurements that are fundamentally inadequate.

These older radiance measurements all have fairly crude angular (or temporal) resolution, usually in the 10°-2° range. Obviously, any clear-sky features that are angularly smaller than this will either be eliminated or considerably smoothed. This imprecision in measurement has, in turn, led to models that fail to reproduce a pervasive feature of real atmospheres: a local maximum of brightness that is several degrees above the horizon, not at the horizon.

Independent Research

Detection and Identification of Oil Smoke Through AVHRR Sensors in the Arabian Gulf in the Wake of Operation Desert Storm

Researcher: Lieutenant Commander Chris R. Gunderson, USN

Advanced Very High Resolution Radiometer (AVHRR) imagery of the Kuwait Oil Fires is plentiful. Accurate "now-casting" of oil smoke is desirable because of the direct effect of smoke on visibility and aircraft ceiling, and as a secondary tracer of atmospheric wind patterns. Various images are analyzed in visible, IR, hybrid, and multi-spectrally enhanced channels, and compared to aircraft ground truth data. Results indicate smoke limits may be identifiable, and that a multi-spectral enhancement based on imagespecific user input may be helpful. This project was supported by the Naval Research Laboratory in Monterey, California.

Ocean Expert System (OES)

Researchers: Lieutenant Commander Chris R. Gunderson, USN,
Midshipmen Tom Liner and Justin M. Reeves

Integration of human Oceanographic expertise with computer data bases and algorithms to develop ideal "Tactical Decision Aids" (TDA) for operational naval commands is a generic goal. USNA involvement is multi-faceted. During the summer of 1993, Midshipman Linder will collect, analyze and compare XBT, CTD, XCTD data, as well as perform ADCP data averaging onboard the NATO Research Vessel (NRV) ALLIANCE in the vicinity of the Azores. His effort will help define techniques for OES disparate data averaging and integration. In the summer of 1993, Midshipman Reeves will travel to the Naval Research Laboratory and Fleet Numerical Oceanographic Center, Monterey, California to: (1) Study IR Satellite Image processing techniques, (2) Study satellite image to numerical model "bogusing" techniques, and (3) Define inshore limits of useable data from IR satellite images in tactically significant climatological regimes. Lieutenant Commander

Chris Gunderson, as an experienced operational forecaster, is working with Dr. Lee Dantzler of the Johns Hopkins University Applied Physics Laboratory to integrate existing data sources and algorithms in efficient ways to maximize the disparate capabilities of human (expert interpreters) and computers (expert numerical processors and data storers) Products will include TDA's.

Oceanographic Investigation of the Chesapeake Bay

Researchers: Associate Professor Peter L. Guth, Assistant
Professor Mario Vieira,
Midshipmen 1/C Damien A. Bailey, 1/C Michael W. Gleeson, 1/C Heather C. Keane
3/C Michael M. Barna, 3/C Christopher R. Cleary, 3/C Matthew T. Collins, 3/C John M. Dianni
3/C Aaron W. Dimmock, 3/C Alan W. Dix, 3/C Gregory A. Francioch, 3/C Brian K. Genton
3/C Robert C. Gomez, 3/C Debra A. Kauffman, 3/C Lisa A. Lelli, 3/C Christine M. Speedling
3/C Mark A. Stiffler, 3/C Tabatha A. Trotter, 3/C Todd M. Westerman, 3/C Travis J. Wilcox
3/C Frederick E. Wilmot

During the summer of 1993, the Oceanography Department conducted a military summer elective research cruise in conjunction with the Division of Professional Development. More than one hundred oceanographic stations were occupied throughout the Chesapeake bay. Data obtained related to physical, biological, geological, and chemical parameters. Technologically advanced instrumentation and modern techniques of data reduction were used by the midshipmen. Results of this cruise were presented to the Academic Dean and Provost and the Oceanography Department faculty.

The Natural Rainbow & Passive Remote Sensing

Researcher: Visiting Professor Raymond L. Lee, Jr.

This project requests continued research support for optical remote sensing of the natural rainbow. Natural rainbows are defined as those seen in rain showers, or in water droplet sprays which have drop size spectra similar to rain showers. As demonstrated in an earlier National Science Foundation grant (number ATM-8607577), remote sensing of such geophysical phenomena can clearly tell us whether existing theories are adequate, unnecessarily detailed, or inadequate to explain naked-eye observations.

Ultimately, the goal is to develop a consistent theory of the natural rainbow, which means one with a nearly uniform level of complexity from the light source to the observer. Each portion of such a theory is necessary, and the whole theory is sufficient, to account for the appearance of all natural rainbows. Earlier research showed that, in order to develop such a theory, an increase in the sophistication of observations was needed. This could be accomplished by examining detailed spectroradiametric data from natural rainbows, a task not possible with our existing equipment.

The project is divided into two major parts: theoretical and experimental. The theoretical part is itself divided into two portions, the forward problem and the inverse problem. These are as follows: (1) Forward problem--develop a consistent theory of the natural rainbow and use it both to circumscribe the range of possible images, and to calculate the appearance of specific bows; and (2) Inverse problem--determine the information content in the variability of natural bows, and determine the meteorological circumstances that give rise to a particular bow.

The research will make comparisons between the chromaticity curves of natural and theoretical rainbows to assess whether the theory adequately circumscribes the variability of nature. In addition, use selected natural bows to perform inversions.

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Comparison of El Chichon and Mount Pinatubo Erupton Clouds Using MCSST Data

Researcher: Visiting Professor Alan E. Strong

One of the key factors in assessing the climatic impact of the Mount Pinatubo eruption of 15 June 1991 is the relative size of this eruption as it compares with other eruptions. As a first approximation, the climatic changes observed after those earlier eruptions can be used to predict the changes to be expected from the more recent eruption. Ideally, this intercomparison should be done with a common measurement system. Data from the advanced very high resolution radiometer (AVHRR) onboard the NOAA polar orbiting environmental satellite can be used to compare the optical properties of the aerosol layer produced by the two most recent major volcanic eruptions, El Chichon, early April 1982, and Mount Pinatubo, mid-June 1991. The error introduced into the multi-channel sea surface temperature (MCSST) fields by the volcanically-produced stratospheric aerosol layer to make a relative comparison of the size of the two eruptions. We also use aerosol optical thickness (AOT) estimates from the visible reflectance channel of the AVHRR to verify that the MCSST errors are indeed related to aerosol particle concentration in the stratosphere. During the first three months following both eruptions, these comparisons reveal that Mount Pinatubo introduced slightly less than twice (1.6 to 1.9) the amount of aerosol into the stratosphere as El Chichon.

Development of High-Resolution Monthly Mean MCSST Product

Researcher: Visiting Professor Alan E. Strong

Using weekly average MCSST data derived from NOAA's AVHRR, monthly mean sea surface temperature products are being refined to expand the presently produced 2.5 lat/long spatial resolution to 36km (1/3rd degree lat/lon). These higher resolution products permit anomaly imagery to be produced that retain the monthly and yearly variabilities of most ocean current systems. These features were not resolved with the older monthly mean product. In addition, statistical summaries are being accumulated that portray zonal, regional, and global SST trends during the past 12 years of data taking.

Research Course Projects

Ocean Floor Weathering - Elemental Changes with Depth as Determined by PIXIE

Researcher: Midshipman 1/C Anthony F. Gilless, USN
Adviser: Professor Douglas W. Edsall

Three basalts dredged from different Atlantic Ocean sites by Woods Hole Oceanographic Institution vessels have been analyzed for their elemental concentrations using the Naval Academy Tandem Accelerator Laboratory's Proton Induced X-Ray Emission (PIXIE) instrument.

The concentration of the elements were measured along transects several centimeters long which extended inward from the specimen's weathered/glassy surface. Initial results show

decreases in Ca, Fe and Ti concentrations with depth, while other elemental variations display no distinct trend. The observed variations in concentration with depth clearly show the removal of Ca, Fe and Ti from the basalts. Work is continuing based on these initial results.

Modification of YP686 for the Conduct of Hydrographic Survey

Researchers: Midshipman 1/C Jeffrey B. Hill, USN and
Lieutenant Commander Chris R. Gunderson, USN

A cruise aboard NOAA Vessel RUDY greatly enhanced the researcher's understanding (gained through participation in SO486A: Introduction to Hydrography) of the Hydrographic Science. Feasibility of Converting the Oceanographic Research Platform, YP686, to a platform also capable of state-of-the-art Hydrography was examined and a positive conclusion was reached. Specific options are provided including costs associated with each.

Intensification Processes and Hybrid Characteristics of the Explosive Atlantic Maritime Storm, 2 - 5 January 1992

Researcher: Midshipman 1/C Richard A. Schilke, USN
Adviser: Associate Professor David R. Smith

The destructive capability of hazardous sea conditions created by explosively deepening wintertime marine cyclones over the western North Atlantic is no secret to the mariners who sail the region. Likewise, tropical cyclones are powerful marine storms which cause death and destruction. Both are powerful, and both develop over water. Yet, meteorological theory developed over the past several decades has placed these storms in distinctly separate categories: tropical and extratropical. Nevertheless, more recent studies and improved data collection have led to the detection of storms with many similarities in structure, appearance, and impact.

Between 2 - 5 January 1992 a dramatic example of an explosively developing cyclone over the western North Atlantic occurred. The uniqueness of this storm lies in its warm core structure, formed from an easterly wave-like circulation at low levels in a large area of thunderstorm activity, and impacted the mid-Atlantic U.S. coast with hurricane-force winds, rain, and storm surges. The system most resembled a tropical storm in its spiral-banded structure and clear eye-like center. Though the storm was aided by extratropical baroclinity, it maintained, even accentuated, its tropical characteristics throughout its lifecycle. Based on normal tropical storm criteria it could have been named! This study shows the likelihood of an interaction between synoptic, meso-, and cloud-scale dynamics which may eventually lead to more widely applicable theories and improved model prediction.

This project was performed in collaboration with operational meteorologists at the National Weather Service Forecast Office in Sterling, Virginia.

The "Redskins" Storm - 4 January 1992: Mesoscale Features and Diagnostic Analysis of an Extratropical Cyclone

Researcher: Midshipman 1/C Richard I. Scritchfield, Jr., USN
Adviser: Associate Professor David R. Smith

Rapidly intensifying cyclones can become quite severe in the winter months, especially over coastal and marine areas. These storms can produce gale-force winds, copious amounts of precipitation, and

Developing a Coral Bleaching Index Using SST Data off Bermuda

Researcher: Midshipman 1/c Richard S. Montgomery, USN
Adviser: Visiting Professor Alan E. Strong

A weekly time-series of satellite-derived multi-channel sea surface temperatures (MSCCT) during the period from 1982 to the present have been compared with in-situ SST values obtained routinely by the Bermuda Biological Station (BBS). This location, off the southeast coast of Bermuda, is close to a site where elevated temperatures have been implicated in causing recent episodes of coral bleaching. An examination of coincident satellite and in-situ SSTs reveals the periods of time where the advanced very high resolution radiometer operational algorithms used. Nighttime MCSST data (only) have proven most comparable in this evaluation. In general, the good overall correspondence between the two SST time series gives us confidence in-situ data are not available. An index is presented for flagging potential periods of coral bleaching based on a weekly mean temperature threshold. Furthermore, it is suggested that MCSST data could be utilized in a similar fashion throughout all the tropical oceans for the identification of coral bleaching.

Publications

FOERSTER, John W., Professor, "Northeast North Pacific Ocean: Surface Current Pattern Shifts During the Spring," Remote Sensing Environment, 43 (February 1993), 149-159.

This work is a study of the interaction of the wind and the sea where easterly moving geostrophic flow becomes eastern boundary currents. To be as synoptic as possible, a satellite time series study (1983 through 1989) and an oceanographic survey (1989) concentrates on the Pacific Ocean Surface waters adjacent to the northwest coast of North America. The hypothesis tested is that the changes in temperature contours of the sea surface infers a shift in current patterns. Of special interest are the surface current patterns during the spring transitional period (1 March through 15 June). This is the time when the California current begins to dominate the eastern boundary currents, and biological production increases. At this time, the predominant wind patterns over the North Pacific change. These changes affect the water masses where the West Wind Drift becomes the California Current. By using the Advanced Very High Resolution Radiometer (AVHRR) aboard NOAA's polar orbiter satellites, a pattern of current shifts over time is measurable. The results from analyzing 53 images over 7 years show a noticeable and distinct shift in surface temperature patterns during the spring period. This pattern shift was visible over time and space, and reflects the effect of the wind in changing the pattern of surface water current flow. Although limited in time and space, the ship deployed instruments, also, reflect these changes and allow a look at the physical processes in the mixed layer.

GUTH, Peter L., Associate Professor, (Microcomputer application of digital elevation models and other gridded data sets for geologists:) eds. Merriam, D. F., and Kurzel, H., Use of Microcomputers in Geology, *Proceedings* International Geological Congress, Computer applications Series], Plenum.

Digital data sets such as elevation models, bathymetry, gravity, and magnetics have great applicability for geologists. They can easily be manipulated on a personal computer to better visualize and analyze the data. In addition, the computer can produce a number of derivative products like slope or shaded images.

GUTH, Peter L., Associate Professor, (Spatial analysis of DEM error:ASPRS/ACSM/RT 92 Technical Papers) American Society for Photogrammetry and Remote Sensing/American Congress on Surveying and Mapping/Resource Technology 92, Washington DC, 3-8 August 1992, 2(1992), 187-196.

Analysis of independently derived, comparable scale

digital elevation models (DEMS) covering the same area suggests that the differences between the two DEMs do not have a random distribution. Where the two DEMs differ in elevation, at least one must be in error compared to the true elevation by at least half the difference between the two DEMs. Large deviations between the two DEMs correlate with calculated slope, aspect (downhill direction), and the reflectance value seen by a satellite. If one of the two DEMs consistently has higher elevations than the other for points with a northeast aspect, the second DEM will be consistently higher for points with a southwest aspect. Deviations depend on aspect because aspect influences shadows on the imagery used to create the DEMs. This suggests that errors in DEMs will also correlate with patterns in the topography.

SMITH, David R., Associate Professor, "Developing the Five Themes of Geography through Topics in Meteorology and Oceanography," to appear in the *Preprint Volume of the 3rd International Conference on School and Popular Meteorological and Oceanographic Education*, Amer. Meteor. Soc., Boston Massachusetts, 15 July 1993, pp. 184-187.

The study of the atmosphere and ocean provides a tremendous opportunity for integrating material across traditional educational disciplines. From the science perspective, both meteorology and oceanography draw upon material from physics, chemistry, biology, mathematics and computing science, providing a vast amount of interesting and stimulating examples relevant to students' experiences. Further, weather, climate and ocean topics also can be utilized in the social studies classroom to integrate science into a broader educational experience.

Through the efforts of the National Geographic Society, a nationwide program of state geography alliances have been established to promote geography education. The intent is to utilize the cross-disciplinary nature of geography to enhance the educational experience in a more integrated fashion. Clearly, there are strong connections between weather and ocean topics and geography which can enrich the learning of both science and social studies. For example, the theme for National Geography Awareness Week this past year was water resources, which has obvious implications for the science curriculum as well as for geography and other social studies.

This paper explores the connection between the science and social studies classrooms utilizing weather, climate and ocean topics. In particular, this paper demonstrates how such topics can be implemented to promote the five fundamental themes of geography: location, place, relationship within places, movement, and regions. Water resources, integrating meteorology, oceanography and geography, will be presented to demonstrate how to teach the five themes of geography across the curriculum. Such an approach is consistent with the goals of Project 2061 of the American Association for the Advancement of Science, which recommends interweaving both science and social studies as a mechanism to promote science literacy and to enhance the study of science-technology-society issues.

SMITH, David R., Associate Professor, "The Atmospheric Education Resource Agent (AERA) Program: Development and Implementation of a Nationwide Network of Teachers to Promote K-12 Science Education", to appear in the *Preprint Volume of the 3rd International Conference on School and Popular Meteorological and Oceanographic Education*, Amer. Meteor. Soc., Boston, Massachusetts, 15 July 1993, pp. 31-35.

Project ATMOSPHERE is the K-12 educational program of the American Meteorological Society. A major component of Project ATMOSPHERE is the Atmospheric Education Resource Agent (AERA) program, a network of pre-college teachers to assist with the implementation of the AMS K-12 educational initiatives. This paper will describe the AERA program and its role in Project ATMOSPHERE.

AERAs are K-12 teachers from across the nation who have participated in one or more AMS workshops for teachers. These teachers comprise a national network linked through the AMS Education Office to enhance the background of K-12 science teachers on topics in meteorology and physical oceanography. Many of these teachers first became involved with AMS K-12 educational activities through the 2nd International Conference on School and Popular Meteorological and Oceanographic Education. Today, these AERAs are conducting in-service training for their colleagues in their local or neighboring school districts as well as at state, regional, or national science education conferences. Many are also assuming leadership roles in science education organizations, providing valuable input and innovative ways to implement weather and ocean topics into science curriculum.

This paper describes the AERA program, focusing on the training provided by AMS through Project ATMOSPHERE. In addition, it also examines some of the contributions of AERAs to implement the goals of Project ATMOSPHERE and their impact on improving K-12 meteorological and oceanographic education.

SMITH, David R., Associate Professor, co-author, "American Meteorological Society Project ATMOSPHERE 1992 Workshop for teachers", *Bulletin of the American Meteorological Society, 74(3)*, 421-424.

Project ATMOSPHERE is the K-12 educational program of the American Meteorological Society charged to enhance the teaching of atmospheric science in elementary and secondary schools. One initiative to achieve this objective was the establishment of the Atmospheric Education Resource Agent (AERA) program, a national network of specially selected precollege teachers who assist in training other K-12 teachers in a variety of atmospheric topics. Those teachers, designated as AERAs, participate a summer training programs to enhance their background in atmospheric science and their leadership skills.

The 1992 Workshop for Teachers was held in Boulder, CO. 49 teachers from 34 states attended this workshop, which focused on meteorology as a physical science and an orientation to global climate change. The workshop included classroom instruction, hands-on exercises, guests speakers, and field trips to a variety of research laboratories in the Boulder area. Such activities provide an excellent opportunity and educational experiences for teachers to become fully-prepared in their partnership role with the American Meteorological Society to promote precollege science education.

STRONG, Alan E., Visiting Professor, co-author, "An MCSST Climatology: 1984-1990," *EOS, 73*(43), 264.

Weekly composites of separated daytime and nighttime MCSST observations from NOAA's AVHRR have been averaged into monthly means during the period 1984 to 1990. This seven-year period of data was chosen to eliminate volcanic aerosol problems during 1982-1983 and more recently from Mount Pinatubo in 1991. Data have been reconstituted onto a global 36km grid (1024x512).

The much higher resolution available from

MCSST-only compares favorably overall with the more coarse climatologies of the past but yields considerably more definition of major current systems. This permits new detail in anomaly fields that reveal year-to-year differences in the locations of these currents. The new charts give considerably more detail to events such as El Nino during 1987 and "La Nina" in 1988 than has previously been possible from climatologies of the past, derived solely from in-situ data.

Problems still persisting with the existing MCSST observations during the past 11 years of record need to be corrected before this entire record can be reliably utilized for climate studies.

STRONG, Alan E., Visiting Professor, 1992: Monthly time-series of coincident in-situ SST and MCSST, *EOS, 72,* 74.

For the past ten years, multi-channel sea surface temperatures from NOAA satellites have been produced operationally. Considerable debate has focussed around the accuracy of the operational algorithms used by NOAA and the ability to both adequately remove water vapor and address occasional episodes of global or regional aerosol contamination. Most of these examinations have centered around <u>individual</u> retrievals and match-ups with drifting buoy observations.

This study examines <u>monthly</u> mean coincident grid-point data from 1984-1990. These data have been separated hemispherically, latitudinally, and by ocean basin to examine the short-term time series tendencies of both conventional and satellite SSTs. For a grid-point to be considered for a coincident measurement, both one monthly mean satellite SST observation and at least five in-situ SST grid values must be available. The 1982-83 "El Chichon" years were omitted from this study.

Global and hemispherical, average differences (biases) during the seven year period are small for the regions employed, never exceeding 0.1°C. The standard error of estimate, although a bit larger, is well below the individual match-up accuracies (±0.7°C) from drifting buoys. Most importantly, no trend is found in these slight differences observed during the period.

Overall the global summary finds good agreement between satellite and conventional SSTs. As the regions become smaller the monthly, and especially seasonal, variabilities become noticeably larger. Some of these seasonal variations may be revealing ship-induced heating at high latitude during winter.

OCEANOGRAPHY

STRONG, Alan E., Visiting Professor, "A Note on The Possible Connection Between The El Chichon Eruption and Ocean Production in The Northwest Arabian Sea During 1982," *Journal of Geophysical Research*, 98 (C1), 985-987.

The coastal zone color scanner (CZCS) has provided what may be the most convincing evidence to date of a large-scale ocean response to a volcanic eruption. Brock and McClain's (1992) 4-year time series of pigments over the Arabian Sea appears to reveal a slowdown in production over much of this basin. Apparently, the entire southwest monsoon relaxed beneath the tremendous pall of the El Chichon aerosol cloud that had overshadowed the region 4 months earlier, producing dramatically reduced concentrations of phytoplankton during summer and fall 1982.

STRONG, Alan E., Visiting Professor, "Sea Surface Temperature Signals from Satellites," *Encyclopedia of Earth System Science*, Vol 4, (ed. W. A. Nierenberg, San Diego, California, pp 69-80.

Satellite derived observations of sea surface temperatures (SSTs) have been used routinely during the past ten years to provide a more complete monitoring of our planet's ocean. The more conventionally derived SSTs from ship and buoy platforms provide an important satellite validation for maintaining accuracy in this increasingly used remote sensing measurement from polar orbiting NOAA satellites. These in-situ measurements have provided a valuable record during the past few centuries that has been admittedly incomplete, especially over the Southern Hemisphere. With the inclusion of operational satellite multichannel SST (MCSST) observations, our oceans are much better monitored as we watch and wait for any signs of global warming and further changes in our global climate over the next few decades.

VIEIRA, Mario E. C., Assistant Professor, co-author, "Between the Delaware and the Chesapeake: Results of a Towed CTD Transect" *Transactions of the American Geophysical Union*, 74, 16/supp (1993), 181.

A programmable towed CTD was utilized during a research cruise with midshipmen from the U.S. Naval Academy in July 1992. An almost continuous transect was taken from the mouth of the Delaware Bay to the entrance of the Chesapeake Bay; the ship's track went far enough East to get into the Gulf Stream. The 2-D structure of salinity, temperature and sigma-tee of the upper layer was resolved and contoured. The data, presented as vertical cross sections, are suitable for use in classroom discussions and exercises. Ground-truth observations of the western wall of the Gulf Stream are correlated with satellite images of the same area.

VIEIRA, Mario E. C., Assistant Professor, co-author, "On the Contribution of Subtidal Volume Fluxes to Algal Blooms in Long Island Estuaries," *Estuarine Coastal & Shelf Science*, 36 (January 1993), 15-29.

A bloom of a new picoplankter species *Aureococcus anophagefferens* occurred in several estuaries in the northeast coast of the United States in 1985. The phenomenon is believed to be the result of a complex chain of physical-chemical-biological factors. Based on 9 years (1980-1988) of tidal data taken at three oceanic locations (Nantucket, Montauk, and Atlantic City) and four impacted estuaries on Long Island (Peconic, Shinnecock, Moriches and Great South Bay) it was found that the variance of the sea level fluctuations at subtidal frequencies was much higher than that of the tidal frequencies and highly dependent upon the season. These subtidal variances reached an absolute minimum in the spring of 1985, corresponding to the lowest subtidal volume exchange between shelf waters and the estuaries. Subtidal flushing times were computed taking into account an estimated recirculation parameter. These times were at an absolute high in the spring of 1985; increases of 16, 24 and 12% were determined for Great South Bay, Moriches and Shinnecock respectively. Along with reduced freshwater inflows due to the existing drought, the increased flushing times may have supported a longer permanence of available inorganic nutrient compounds contributing to a favorable environment for the ecological dominance of *Aureococcus*. The low subtidal sea level fluctuations of 1985 are related to a minimum energy content of the regional wind stress, particularly the alongshore (East-West) component which is responsible for the Ekman pumping into and out of the estuaries.

VIEIRA, Mario E.C., Assistant Professor, co-author, "Plume Dispersion of Dilute Suspensions: A Model of Barge Overflow Adapted for Use in A Personal Computer," *Water Science & Technology*, 25, 9 (1992), 173-179.

A practical method was developed to estimate the areal extent of the plume associated with the overflow of dredged material during barge filling operations in shallow waters. The predictive model is based on the Okubo-Pritchard relationship for horizontal diffusion; it solves the transport equation which governs the distribution of total suspended solids or dissolved species. The model runs on a Personal Computer and provides the spatial distribution of particulate concentrations in the plume from minimum information on local hydrography, the intensity of advective and dispersive processes and the characteristics and discharge rate of the dredged material. The extent of the plume is defined as the isoline of acceptable concentration of a specified material. The rate of decay of the plume once the overflow terminates is also computed.

VIEIRA, Mario E.C., Assistant Professor, co-author, "The Role of Environmental Changes in An Unusual Coastal Plankton Bloom," *ICES Marine Science Sympos?* Norwich, UK: Editorial International, 195 (1992), 223-231.

Certain embayments on the northeast coast of the United States experienced previously undocumented microalgal blooms called "brown tides" during the summer of 1985. A small (2-3 µm), previously unidentified chrysophyte species, *Aureococcus anophagefferens*, was found to be responsible for these blooms. The blooms recurred in several bays during the summer of 1986, subsequently waning in 1987 and 1988, and finally disappearing in 1989. Investigations of causes of these novel blooms have indicated that perturbations in climate were in part responsible. Specifically, the onset of drought conditions and variations in wind regimes resulted in hydrological changes in the affected areas. Comparison of significant environmental variables between bloom and non-bloom areas throughout the 1980's has elucidated important regional and local factors in bloom initiation and maintenance. A dynamical system model has been utilized to determine the threshold levels of key variables and to assist in understanding the underlying mechanisms which lead to the onset of such unpredictable bloom events.

VIEIRA, Mario E.C., Assistant Professor, co-author, "Near-Inertial Motion on The Shelf/Slope Front off Northeast Spain," *Journal of Geophysical Research*, 97, C5 (1992), 7277-7281.

Near-inertial motion on the shelf-slope front off northeast Spain was monitored using surface drifters and moored current meters. On the shelf, strong inertial currents were generated by a wind burst. The inertial current amplitude was about 70 cm/s at the surface, 30 cm/s at the base of the mixed layer, and 10 cm/s in the interior. The observed near-inertial frequency on the shelf was about 10% lower than the local inertial frequency, suggesting that the near-inertial motion was embedded in a region of strong anticyclonic shear. Also, the phase of near-inertial motion increased through the water column, indicating that the energy propagation was downward. By contrast, the surface inertial currents were only about 10 cm/s in the center of the shelf-slope front. Indirect evidence suggests that the observed small surface inertial currents were the result of rapid downward transfer of near-inertial energy in the front.

VIEIRA, Mario E.C., Assistant Professor, co-author, "On The Use of State-of-The-Art Equipment at The U.S. Naval Academy," *Transactions of the American Geophysical Union*, 73, 14/supp. (1992), 161.

Midshipmen from the U.S. Naval Academy utilized a programmable towed CTD to collect data during a transect through the Gulf Stream in July 1991. The 2-D structure of the salinity, temperature and σ_t of the water to a depth of 50 m was resolved and contoured. The data, presented as cross-sections, are suitable for use in classroom discussions and exercises. Another state-of-the-art instrument, a vessel mounted Acoustic Doppler Current Profiler, was used at three anchor stations. The measurements were taken during complete tidal cycles at locations near the mouths of the Chesapeake and Delaware Bays and also in a tributary of the northern Chesapeake Bay. Current, temperature and depth data were analyzed to investigate the characteristics of the tide wave as a function of location in the estuary, time and depth.

Presentations

FOERSTER, John W., Professor, "Estuarine Biofiltration: Trace Metals in the Livers of Oyster Toadfish (Opsanus tau)," Geochemistry Section, American Geophysical Union, Baltimore, Maryland, 26 May 1993.

FOERSTER, John W., Professor, "Newsletter Construction and Use," National Science Foundation Workshop on Constructed Wetlands, Fort Collins, Colorado, 28 July 1992.

GRIESER, Kenneth J., Midshipman 1/C, USN, and Peter L. GUTH, , Associate Professor, "Improved Sea Ice Concentration from Passive Microwave Data using GEOSAT T2GDR's," 1993 Spring Meeting, American Geophysical Union, Baltimore, Maryland, 25 May 1993.

GUTH, Peter L., Associate Professor, and Brian RIES Midshipman 1/C, "Lithologic differentiation with X-band Side-looking Airborne Radar, Indian Springs Quadrangle, Nevada: [Joint Cordilleran-Rocky Mountain section meetings of the Geological Society of America, May 1993, Reno, Nevada] [SO495 Project].

GUTH, Peter L., Associate Professor, co-author, "Computer-generated Color-coded Topographic Maps and Three Dimensional Displays of The 'Hill of Vision'," Annual Meeting of the American Academy of Ophthalmology, Dallas, Texas, 10 May 1992.

GUTH, Peter L., Associate Professor, "Spatial Analysis of DEM Error," American Society for Photogrammetry and Remote Sensing/American Congress of Surveying and Mapping Global Change Meeting, Washington, DC, 5 August 1992, , in conjunction with XVII International Society Photogrammetry and Remote Sensing International Meeting.

LEE, Raymond L, Visiting Professor, "Horizon Brightness Revisited: Measurements and a Model," Topical Meeting on Light and Color in the Open Air, Pennsylvania State University, University Park, Pennsylvania, 15-16 June 1993.

LEE, Raymond L., Visiting Professor, "Daytime and Twilight Colors of the Clear Sky," Topical Meeting on Light and Color in the Open Air, Pennsylvania

State University, University Park, Pennsylvania, 15-16 June 1993.

SMITH, David, R., Associate Professor, "Developing the Five Themes of Geography through Topics in Meteorology and Oceanography," The Third International Conference on School and Popular Meteorological and Oceanographic Education, Toronto, Ontario, Canada 17 July 1993.

SMITH, David R., Associate Professor, "The Atmospheric Education Resource Agent (AERA) Program: Development and Implementation of a Nationwide Network of Teachers to Promote K-12 Science Education," The Third International Conference on School and Popular Meteorological and Oceanographic Education, Toronto, Ontario, Canada 15 July 1993.

SMITH, David R., Associate Professor, "American Meteorological Society's Board on School and Popular Meteorological and Oceanographic Education: Past, Present, and Future", Third International Conference on School and Popular Meteorological and Oceanographic Education, Toronto, Ontario, Canada, 15 July 1993.

SMITH, David R., Associate Professor, "Project ATMOSPHERE Teacher Training Program", Second American Meteorological Society Symposium on Education, Anaheim, California, 13 January 1993.

SMITH, David, R., Associate Professor, "Project ATMOSPHERE: A Nationwide Enhancement in Meteorology for Pre-college Teachers", First Maryland Space Grant Conference, Annapolis, MD 4 October 1992.

STRONG, Alan E., Visiting Professor, and Michael J. BOONE, Midshipman 1/C USN, "An MCSST Climatology: 1984-1990," Fall Meeting of the American Geophysical Union, San Francisco, California, 7 December 1992.

STRONG, Alan E., Visiting Professor and Richard S. MONTGOMERY, USN, Midshipman 1/C "Developing an SST Index for Coral Bleaching of Bermuda, Third Conference of the Oceanography Society, Seattle, Washington, 13 April 1993.

STRONG, Alan E., Visiting Professor and Michael J. BOONE, Midshipman 1/C USN and Richard S. MONTGOMERY, Midshipman 1/C, "AVHRR Research Projects at the U.S. Naval Academy: Using AVHRR MCSST Data to Develop a Coral Bleaching Index at Bermuda; An MCSST Climatology--1984-1990," NOAA Science Center, Camp Springs, Maryland, 12 May 1993.

STRONG, Alan E., Visiting Professor, "1992--The year that Global Warming Stopped," Sigma Xi (Annapolis Chapter), United States Naval Academy, Annapolis, Maryland, 21 October 1992.

STRONG, Alan E., Visiting Professor, "Remote Sensing with AVHRR and CZCS," Maryland Space Grant Conference, United States Naval Academy, Annapolis, Maryland, 2 October 1992.

STRONG, Alan E., Visiting Professor, Interview given to CBS Affiliate WOWK-TV (Huntington, West Virginia) United States Naval Academy, Annapolis, Maryland, 21 January 1993.

STRONG, Alan E., Visiting Professor, Interview given to CNN "Newsroom," United States Naval Academy, Annapolis, Maryland, 1 September 1992.

VIEIRA, Mario E.C., Assistant Professor, "The "Brown Tide" Killer: A Search for The Smoking Gun," Fall meeting of the Atlantic Estuarine Research Society, Annapolis, Maryland, 30-31 October 1992.

VIEIRA, Mario E. C., Assistant Professor, "On The Relationship between Subtidal Flushing and The Occurrence of Blooms in A Shallow Estuary," Joint Conference of the Estuarine and Coastal Sciences Association/Estuarine Research Federation on Changes in Fluxes in Estuaries, Plymouth, United Kingdom, 13-18 September 1992.

Physics

Professor Robert N. Shelby
Chair

T he 1992-1993 academic year was another year of active and productive involvement of the Physics Department faculty and students in a broad range of research efforts. As detailed in the abstracts that follow, the range of topics studied included research in physical acoustics, atomic physics, nuclear physics, non-linear optics, condensed matter physics, magnetic signatures, non-linear acoustics, ultra-fast laser systems, the use of proton induced x-ray emissions and galactic astronomy. These projects made use of the several excellent systems at the Naval Academy as well as the Hubble Telescope and several other national facilities like the Naval Research Laboratory.

The health of the research program at an undergraduate institution should be measured by more than the quantity and quality of the published results. There must be a strong component of the effort dedicated to student involvement in the reseach and an understanding of the importance of the faculty being involved with and sharing with their students current techniques and ideas. The nature, breadth, and student involvement in the Physics Department research are signs of a healthy program.

Funding support for research done by Physics Department faculty this year came from the National Science Foundation, the Office of Naval Research, the Naval Research Laboratory, the Naval Surface Warfare Center, the Naval Air Warfare Center (Warminster, Pennsylvania), the Association of Universities for Research in Astronomy, Inc., the Naval Academy Research Council, the National Center for Physical Acoustics at the University of Mississippi, and DuPont de Nemours, Co.

Sponsored Research

Southern Hemisphere Observations of Interstellar Ti II

Researcher: Associate Professor C. Elise Albert

Work has continued on a project to study the scale height of interstellar titanium gas in the galactic halo, in collaboration with Dr. B. Welsh, NASA , and Dr. L. Danly, Space Telescope Science Institute. We observed 6 southern hemisphere stars in 4 nights of obeserving time with the 1.5 meter telescope of the Cerro Tololo InterAmerican Observatory in Chile. The density distribution of interstellar gas away from the plane of the galaxy exhibits complex behavior. Data analysis is underway and preliminary results indicate that the gas phase abundance of titanium continues to increase out to the most distant star in our sample, located at 8 - 9 kiloparsecs from the galactic plane.

Projectile K-Auger Electron Spectroscopy in Fast Ion-Atom Collisions

Researcher: Associate Professor John M. Anthony
Sponsor: Naval Academy Research Council (OMN)

The objective of this experimental project is to investigate fundamental processes which occur when ions contained in a high energy ion beam collide with stationary gas atoms. Auger electron emission by the excited ions are measured using a unique device known as a parallel plate tandem electron spectrometer. Until recently, study of the decay of a projectile ion moving at speeds comparable to that of the electron emitted during decay of the ion has been limited by poor resolution. Because of the projectile's motion, the Auger electron lines arising from different atomic transitions tend to blend together. Our novel experiment utilizes deceleration and refocusing of the electrons and is capable of a factor of 10 improvement in electron energy resolution.

A large number of electron spectra have been measured and analyzed for various combinations of ion energy, target gas and projectile. Until now, these experiments have been carried out at various laboratories across the country (Oak Ridge National Laboratory; J.R. MacDonald Laboratory Kansas State University; and Triangle Universities Laboratory, Duke University). We are in the process of purchasing an electron analyzing system from the P&T corporation of Livermore, California which should be delivered this year. Also, the Physics Department plans to purchase a high vacuum chamber and beam line that will allow these experiments to be carried out on site (at the Tandem Accelerator Lab in Michelson Hall). At present, our main interest is in Carbon and Oxygen Ions containing 4 atomic electrons (C^{2+} or Carbon with two electrons removed; and O^{4+} or Oxygen with four electrons removed).

Using this experimental technique, we are able to study various atomic processes including: (1) electron transfer from the target atom to the projectile ion (capture); (2) loss of a projectile K-shell electron (ionization); and (3) the formation of excited metastable ions during gas or foil stripping of the ion. The collaboration between the researcher and the Atomic Collision group at Kansas State University has resulted in a publication. In this paper, experimental cross sections for K-shell ionization of C^{2+} and O^{4+} ions colliding with H_2 gas atoms is compared with theoretical calculations for enl (electron Ionization by the target nucleus) and eel (electron Ionization by target electrons). The sum of contributions from the two sources was found to be in good agreement with our measurements. Until recently, the so called target "spectator electrons" were thought to play only a passive role of screening the positively charged target nucleus. An abundance of experimental evidence indicates that the electron-electron interaction can play a substantial role in processes such as resonant electron transfer and excitation (RTE). Our findings show that that spectator electrons account for as much as 17% of the total experimental cross-section for ionization.

Future plans include the publication of two additional Journal articles; to continue measuring cross sections for other ions and to establish an experimental program in Michelson Hall by the end of 1993.

Three Acoustical Scattering Studies

Researcher: Professor Donald W. Brill
Sponsor: Naval Research Laboratory

Three short projects were undertaken during this research period: (1) A study was made of the work done by Prosperetti et al on the scattering of acoustical plane waves from a hemispherical bubble swarm at the water's surface; (2) A scattering analysis was made for the scattering of plane waves from a spherical bubble swarm under water. A power series solution was constructed for the radial equation which accounted for a radially dependent sound speed which passed from the sound speed in water at the outer periphery to the sound speed in air at the center of the swarm; and (3) The

scattered pressure from an spherical air bubble under a flat air/water interface was found using the Green's function method. The solution obtained is limited by omitting the pressure scattered from the image bubble at the waters flat surface when imposing the pressure release (p=0) condition there.

Quantitative Elemental Analysis by Particle-Induced X-ray Emission (PIXE)

Researcher: Professor Francis D. Correll
Sponsor: Naval Academy Research Council (ONR)

The Naval Academy Tandem Accelerator Laboratory has been engaged in PIXE analyses for the last two years. During that time, in-air analyses of a variety of materials have been performed, and emphasis has gradually shifted from qualitative to quantitative investigations. Recently-initiated projects seek accurate quantitative information. To provide this information, several careful systematic studies must be performed.

The objectives of the present research were: (1) To develop a technique for accurate proton-dose measurements; (2) to measure the x-ray absorption of several filter materials; (3) to improve accuracy of proton-beam positioning on the sample; and (4) to simplify and improve numerical analysis of x-ray spectra.

A method for measuring proton-dose was implemented that involves counting protons scattered through large angles from the thin foil through which they exit the accelerator vacuum before striking the sample. A new beam-exit window and a backscattered-proton detector assembly were designed and constructed. A compact, magnetically-suppressed Faraday cup was built to calibrate the scattered-proton detector by measuring integrated current under well-controlled conditions.

The x-ray absorption of commercially-obtained thin Al and V foils was measured to assess their suitability as critical absorbers for x-rays from Si and Fe. Thin mylar and thicker acrylic were also studied for use as bulk absorbers, and new filter holders were made to improve filter geometry and uniformity.

A sample positioner was built that uses a stepper motor to move the sample with respect to the beam spot, and a circuit was constructed to mechanically scan the sample when averaging over inhomogeneities is desired. A compact video camera was mounted to monitor the beam position on the sample.

A new PIXE analysis program, called GUPIX, was acquired, installed, and tested. Tests using spectra from pure elements and other standard reference materials have shown that GUPIX yields reliable, accurate results. Analysis of both recently- and previously-collected x-ray spectra using GUPIX is underway.

Electrical Properties of Polymers

Researchers: Professors John Fontanella and Mary C. Wintersgill
Sponsor: Du Pont de Nemours, Co.

The audio frequency dielectric constant and loss have been measured over the temperature range 5.5-300K for various types of polymers including amorphous teflon, EVOH, polypropylene, polyethylene, nylon, and PMMA. The EVOH and nylon samples were measured both "dry" and "wet" and the differences were characterized. Several new relaxations were observed and the activation parameters for each were determined.

Dielectric Relaxation in High Glass Temperature NLO Polymers

Researchers: Professors John Fontanella and Mary C. Wintersgill
Sponsor: Naval Air Warfare Center (Warminster, PA) and the Office of Naval Research

The objective is to use dielectric relaxation techniques to investigate relaxation mechanisms in high glass transition temperature nonlinear optical (NLO) polymers and examine any sub-glass transition temperature relaxations found for associated loss of NLO polymers.

Spatially Resolved Self-Pumping in Photorefractive Materials

Researcher: Assistant Professor Steven R. Montgomery
Sponsor: Naval Academy Research Council (OMN)

This project is aimed at examining self-pumped phase conjugation. The photorefractive scattering that this process depends on is called the beam fan due to its fanlike appearance on one side of the laser beam as it exits the crystal. Portions of the beam fan totally internally reflect off a corner of the crystal and cross the original input beam to produce two regions of wave mixing. As a result of this mixing, and the consequent gratings, a loop of fan light forms within the crystal as well as a phase conjugate beam that exits the crystal exactly opposite to the input beam. The objective of this experiment is to measure the self pumped response of the crystal when a delayed pulse collinearly follows each of the input pulses such that the time difference between the initial and delayed pulses is a continuously variable quantity. By adjusting the delay time coherent light will be forced to cross at the overlap points and produce self pumping. This would provide an important test of the model and could provide a novel scheme for image storage. An optical delay system has been constructed to produce the double pulse train of picosecond pulses. The crystal has self pumped with a single fixed delay between collinear picosecond pulse trains. Given the slow response of the crystal to picosecond pulses, up to thirty minutes per data point, an automated system for changing the delay time has been devised using a Macintosh computer running LabVIEW software. With this system it is possible to rotate the polarization of the input beam to erase a grating, adjust the delay time, rotate or translate the crystal, and record the signal level of the phase conjugate beam.

Studies of Light Amplifiers and Time-Gated Imaging and Optical Oil Analysis

Researcher: Professor Lawrence L. Tankersley
Sponsor: Naval Research Laboratory, Code 5640

The primary effort was a systematic study of transient Raman amplification. M. Duncan and R. Mahon were the full time researchers on the project which Duncan directed. A major effort was made to study imaging through turbid media. Application of imaging techniques in the fields of non-invasive medical diagnostics and turbine engine oil analysis were investigated experimentally and theoretically. A list of the areas of effort follow: (1) Low-light level amplification and imaging; (2) Quantum fluctuations and Raman amplifier noise; (3) Interactions of noise and signal fields in amplifiers; (4) Amplifier dynamic effects - spatial and spectral gain narrowing; (5) Applications to biological studies and engine oil analysis; (6) Analysis of scattered light for image bearing components; (7) Pulse compression for time gated Raman scattering; and (8) Development of support electronics.

Optically Detected ENDOR Measurements in II-VI Semiconductors

Researcher: Professor Donald J. Treacy
Sponsor: Naval Research Laboratory, Code 6877

The aim of this program is to establish models for defects in III-V semiconductors. Electron-Nuclear Double Resonance (ENDOR) probes the fields, as seen by neighboring nuclei, in the immediate vicinity of a paramagnetic center. Optical detection of this signal increases the sensitivity of this technique to the level at which it is possible to obtain data on defects which do not have a sufficient concentration to be observed by traditional ENDOR methods.

The defect observed was a phosphorous atom on an indium lattice site, P_{In}, in the III-V semiconductor InP. An electron trapped at this defect will interact with the central phosphorous atom, the four phosphorous nearest neighbor (NN) atoms and the twelve indium next-nearest neighbor (NNN) atoms. The hyperfine parameters describing the interaction of the traped electron with the central phosphorous and the NN phosphorous atoms have been determined.

The mechanism of the interaction of the trapped electron with the NNN indium atoms is complicated by the presence of a quadrupole interaction in addition to the hyperfine interaction. This feature is being investigated.

Neutron-Proton Structure of Collective Excitations in Cerium-140

Researcher: Assistant Professor Jeffrey R. Vanhoy
Sponsor: National Science Foundation

The structure of N=82 nuclei is interesting because it provides a basis for understanding the effects seen in neighboring nuclei as neutron-pairs are added and taken away. Of particular concern is the use of the particle-to-core coupling model (PCM) where one treats the N=84 nuclei as a neutron pair orbiting a N=82 core which is undergoing vibrations about a spherical shape.

Levels up to 4.3 MeV excitation in ^{140}Ce were studied with the (n,n'g) reaction. Approximately 75% of the $\approx$ 260 g-ray transitions observed have been uniquely placed into a level scheme of 81 levels. Spin assignments have been made for three-fourths of these states. Forty-seven levels had measurable lifetimes and the corresponding transition rates were determined. Agreement of ground state transition rates with those obtained from electron scattering is excellent.

The probe dependence of the scattering amplitudes to collective states allows one to examine the neutron/proton character of states. Our results, when combined with the (p,p') results of Sherman [1977], suggest that the 2^+ state's wavefunction has a slight proton dominance. The octupole excitation is very strong in ^{140}Ce; B(E3;3S(-,1)->0S(+,1)) = 38.5 Wu -- a significant fraction of the recommended upper limit for this mass region [Endt 1981]. Comparison of our electromagnetic results with those from (p,p') indicate equal contributions of neutron and proton components. Neutron scattering measurements (n,n') are in progress by McEllistrem et al. at the University of Kentucky, and will provide an additional check of the character of these states.

Recently, comprehensive shell model calculations for the N = 82 nuclei from ^{133}Sb to ^{154}Hf have been completed by Wildenthal [1991]. We are awaiting receipt of the ^{140}Ce calculations for comparison to our data. The nuclei ^{138}Ba and ^{140}Ce have very similar level structures and therefore conclusions about them should not be drastically different. Excellent agreement is obtained for excitation energies of all states below $\approx$ 4 MeV in ^{138}Ba with the exception of the 3S(-,1). Another group's calculations [Halpern 1969] emphasizing neutron excitations put the neutron particle-hole strength in the region E_x = 3.4 - 4.5 MeV -- well above the 3S(-,1). The magnitude of the disagreement implies that many higher order configurations are required to describe the 3S(-,1) and thus the state is better thought of as an octupole vibration rather than a strong particle-hole state. The excitation energy of the 2S(+,1) on the other hand is well described within the shell model, and substantial collectivity is not required. These conclusions for ^{138}Ba are consistent with the

collective bR amplitudes determined from our electromagnetic decay data in ^{140}Ce.

Fragmentation of Isovector Quadrupole Vibrations in Cerium-142

Researchers: Assistant Professor Jeffrey R. Vanhoy
Sponsor: National Science Foundation

Studying the properties of low-lying nuclear states reveals much information about the behavior of nuclear matter. In the heavier nuclei where many nucleons are involved, it is not possible to keep track of the individual particles and one is forced to use almost exclusively the collective model description. The collective model treats the nucleus as a fluid undergoing vibrations and rotations.

But in fact, the nucleus is composed of neutron and protons -- distinguishable particles, so the nucleus should be considered as a mixture of two separate fluids in certain situations. There are several normal modes of oscillation which could occur. The exotic oscillations are commonly refered to as mixed-symmetry states or isovector states. As in many systems undergoing oscillations, it is becoming apparent that the actual motion of the nucleus is not in pure normal modes. The extent of the fragmentation of isovector vibrations has not been measured in spherical nuclei.

Measurements of ^{142}Ce(n,n'g) angular distributions have been made at incident neutron energies up to $E_n \approx 3$ MeV with intrinsic Ge detectors of resolution ≈ 2 keV. Spins, branching ratios, and transition rates were extracted from the gamma-ray data. The lowest energy mixed-symmetry 2_M^+ excitation is expected to occur at $E_x = 2$-3 MeV. Two rather strong 2^+ to ground state transitions were observed which could share this 2_M^+ strength. This may be analogous to the situation in several other nuclei.

Independent Research

Interstellar Gas in the Galactic Halo

Researcher: Associate Professor C.Elise Albert

A major analysis of neutral interstellar clouds in the lower galactic halo was completed, in collaboration with Dr. D.C. Morton, Director, Herzberg Institute of Astrophysics, Dr. J.C. Blades, Space Telescope Science Institute and Dr. F.J. Lockman, Director, National Radio Astronomy Observatory. Optical interstellar absorption lines of Ti II and Ca II and the 21 cm emission line of H I were observed at high resolution (6 km/sec and 1 km/sec, respectively) and high detection sensitivity along 25 lines of sight in the galactic halo. The data show substantial interstellar material, at both low and intermediate velocities, between 250 and 100 parsecs beyond the galactic plane. As much as one third of the total gas observed in Ca II absorption may be beyond 1 kiloparsec, and the gaseous Ti II may lie in an even thicker layer. The directly determined gaseous titanium abundance above the galactic plane exceeds that in the disk, on the average, by a factor of 4 to 6 and, for individual cloud components, is further enhanced at higher velocity with respect to the Local Standard of Rest. Thirty-three discrete high latitude clouds, with well-determined distance limits, are detected in Ca II absorption and 17 discrete clouds, including 3 high velocity clouds, are identified in H I emission. The kinematics of the high latitude gas observed in Ti II and Ca II absorption is characterized by significant peculiar velocities with respect to a model corotating halo. These results are scheduled

Magnetic Studies of Pulse Laser Deposited Barium Hexaferrite and Magnesium-Zinc Ferrtie

Researchers: Lieutenant Commander Charles A. Edmondson, USN
and Associate Professor James R. Huddle

High quality, epitaxial barium hexaferrite ($BaFe_{12}O_{19}$) thin films have been deposited by pulsed laser deposition (PLD) on to basal plane sapphire. Studies concentrated on the affect of growth parameters, such as substrate temperature and background oxygen pressure, on film properties. This work has been conducted in conjunction with material science researchers at the Naval Research Laboratory in Washington, DC. This technique is also being applied to magnesium ferrite films.

Quasi-Linear Model of Jet-Cavity Interaction Via Vibrating Diaphragm Concept

Researcher: Professor Samuel E. Elder

A new jet-cavity interaction model has been developed allowing both cavity resonance (*half-jet*) and organ pipe oscillation (*full-jet*) to be described by a common approach, using an extension of the *vibrating diaphragm* concept of Yoshikawa and Soneyoshi [J.Acoust.Soc. Jpn (E) 1, 175-191 (1980)]. For the half-jet, or free shear layer, the effective vibrating diaphragm is the moving surface defined by the locus of points at which the shear layer velocity profile has an inflection point. For the organ pipe, back-to-back shear layers provide a pair of coupled "diaphragms" which act similarly. Being the surface that divides "inside" from "outside" fluid, the diaphragm is responsible for parallel-resonant, or jet-drive. Furthermore, the inertia of the diaphragm and adjacent layers is associated with series-resonant, or "force-drive" contributions to the oscillation arising principally from fluctuating deflection of momentum from the main jet flow. The present scheme differs from previous *control-volume* models by dealing explicitly with inner momentum transfer mechanisms, in contrast to earlier "black box" approach. Root locus equations are derived for both laminar and turbulent boundary layers. An important discovery attributable to the new model is that there is a natural lower limit to the Strouhal number for cavity resonators driven by turbulent boundary layers. This asymptotic limit is given by the formula:

$$S = F(fH,U) = 0.2929[M - 0.25] \quad \text{where } M = 1,2,3,...$$

Magnetospheric Physics

Researcher: Associate Professor Irene M. Engle

There are several projects upon which are thought about or worked upon intermittently.

1. Modeling, from first principles, a representation of the Jovian magnetosphere during a semi-inflated state, as observed during the Voyager II flyby. Three papers based on this work have been published in the past 13 months. An additional paper for adaptation to the Ulysses encounter with Jupiter is in preparation.

2. A new look at the Mercury magnetospheric field, in response to a recently published review on Mercury which contains some conclusions which are

not supported by this investigator's experience. Am currently shopping for affordable page charges for publication of completed manuscript. Also, I was contacted by an investigator interested in obtaining time dependent configuration modeling for analysis of some more recently observed photoionization of heavy ions near the disc of Mercury

3. Modeling, from first principles, as in #1, or by scaling from a function set, as in #4., self-consistent, three-dimensional global magnetospheres of Uranus and Neptune.

4. Adapting alternate sets of orthogonal functions for three-dimensional representation of magnetospheres for earth and other planets with intrinsic planetary magnetic fields.

5. The relation of observed temporal variations of magnetospheric configurations to the proximate causes and consequential phenomena; investigations of the mechanisms for transport of particles, momenta, and energy related to the aforesaid phenomena.

6. I have recently been recruited to assist with the modeling, from first principles, a representation of the Saturnian magnetosphere as observed during the Pioneer 11 and Voyager I and II flybys. The work is in support of the charged particle investigations of the future Cassini mission, which is to place an orbiter about Saturn.

Research Course Projects

Particle-Induced X-ray Emission Analysis

Researcher: Midshipman 1/C Kenneth L. Ferguson, USN
Adviser: Professor Francis D. Correll

Elemental compositions were determined for a variety of samples using Particle-Induced X-ray Emission (PIXE) analysis. The samples included rocks from deep-ocean hydrothermal vents, archaeological artifacts from Historic St. Mary's City, and tissue samples from Chesapeake Bay crabs, oysters, and toadfish. Goals of the research included both the refinement of the PIXE technique as well as evaluation of the particular samples for mineral content, trace elements, and hazardous elements. X-ray spectra were obtained using a multi-channel analyzer and an MS-DOS computer, and elemental compositions were obtained by analyzing the spectra with the GUPIX program. The hydrothermal-vent rocks contained small, but measurable, quantities of Au and Ag, and the tissue samples contained only low levels of heavy metals. The archaeological samples showed corrosion and calcite formation on exposed surfaces. The measured elemental compositions of all samples were in reasonable agreement with typical values obtained from the literature, supporting the use of PIXE for analyzing these types of materials.

Estuarine Biofiltration: Trace Metals in the Livers of the Oyster Toadfish (_Opsanus Tau_)

Researcher: Midshipman 1/C Scott D. Smart, USN
Advisers: Professor Francis D. Correll and
Professor John W. Forester (Oceanography Department)

Oyster toadfish (_Opsanus Tau_), as part of the estuarine benthic food web, extract potentially toxic environmental trace metals. To test this hypothesis, we began a study in September of 1992 on toadfish resident in the Chesapeake Bay near Annapolis, Maryland. This area was away from any direct industrial or commercial effluents carrying trace metals but has concentrations of trace metals in the benthic soil. The study had two purposes. The first was studying a benthic shellfish predator to see if

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potentially toxic trace elements concentrated. Also, we decided that all testing would concentrate on the physiologically important organ, the liver. Second, we wanted to test methods we developed for use with a proton-induced x-ray emissions (PIXE) system. Analysis of 17 various sized toadfish showed that the livers contained concentrations of Chromium (5.9-51.7 mg/l), Copper (3.3-26.0 mg/l), and Zinc (8.6-29.9 mg/l). These trace metals

absorbed as a function of environmental concentration and not the size or age of the fish. Therefore we established that the liver does show the concentration of trace metals. We need further work on the effects of these trace metals on the fish and the environmental concentrations. In addition, the PIXE system allowed us a rapid method to determine trace metal concentrations.

Ocean Floor Weathering: Elemental Changes with Depth as Determined by PIXE

Researcher: Midshipman 1/C Anthony E. Gilless, USN
Advisers: Professor Francis D. Correll and
Professor Douglas W. Edsall (Oceanography Department)

A suite of basalts dredged from various Atlantic Ocean sites by Woods Hole Oceanographic Institution vessels has been obtained for measurement of elemental composition in the Naval Academy Tandem Accelerator Laboratory by Proton-Induced X-Ray Emission (PIXE). The objective of our research is to analyze changes in composition of these ocean floor basalts along transects several centimeters long which extend inward from the specimen's weathered/glassy surface. Preliminary results indicate that elements

as light as Mg can be detected if their concentrations are in the ppm range. Work is continuing on the initial suite of basalts, and differences in elemental composition and abundances are observed both as a function of depth and individual sample. We will present the results of our correlation with published chemical analyses and relate our observations to the alterations caused by the interaction of cold sea water and the basalt.

Investigating the Effects of a Low Pass Filter on the Intelligibility of a Signal

Researcher: Midshipmen 1/C Jeffrey S. Davis, USN
Adviser: Professor Samuel A. Elder

When a sound is limited in bandwidth, information about that signal is lost. By passing a list of words through a low pass filter, set at different cutoff frequencies, we find a function of sufficient information versus the composition of the signal and the cutoff frequency. These cutoff words are recorded and played back for a listener, who writes down the word according to his comprehension. By graphing the average percent correct per cutoff value, a general curve of this function is formulated and a best lowest cutoff is found. The separate words tested are analyzed to understand the difference in the signals and why some need more information to be passed than others; a low cutoff

value destroys the understandability of the word as a function of its signal. Spectral analysis of spoken words and their formats provide an adequate basis for understanding the intelligibility of word lists under limited band conditions. The first experiment was designed to explore the effect on intelligibility of words when passed through a variable band-limiting filter. Calibrated monosyllabic word lists were employed, with a number of student volunteers acting as "guinea pigs" making word identifications through headphones. In a second experiment certain words with similar sounds were studied with a view to understanding why some are easily mistaken while others are correctly identified

even when the upper filter cutoff is as low as 400 Hz. Data from a number of runs were combined to produce an "Intelligibility" curve indicating the probability of an arbitrary word from the list being understandable as a function of high-frequency cutoff. It was found that for 90% of the words tested, a low pass cutoff of 1000Hz allows an acceptable amount of information to pass.

Comparing the Voyager II Jupiter Encounter Magnetic field Measurements with Three-dimensional Self-consistent Magnetospheric Field Models.

Researcher: Midshipman 1/C Coley C. Chappell, USN
Adviser: Associate Professor Irene M. Engle

The objective was to compare magnetometer measurements obtained by Voyager II with predictions of a set of global self-consistent magnetospheric models which incorporate the fact that the Jovian magnetic axis is tilted approximately $10°$ with the normal to the Jovian equator and precesses with each Jovian rotation of period $9^h 55^m$. The project will result in a better understanding of this investigator of global magnetospheric structure theory as well as observations and will hopefully provide a service to the space science community. Additional objectives were to learn to manage large data sets and learning to apply maximum likelihood theory of fitting of data to theory.

The Voyager II mission was the fourth of the total of 5 planetary exploration missions to fly past Jupiter, entering the magnetosphere of Jupiter and measuring magnetic field components on a single line of trajectory. All of the first four flyby encounters shared the characteristic of arriving in the Jovian neighborhood in advance of the planet, remaining approximately in the ecliptic plane throughout the encounter, and then using additional energy acquired via the gravitational interaction with the massive, rapidly moving planet, to travel further out in the solar system. All of the encounters observed the effects of a significant corotating plasma sheet. The data sets for the Voyager II mission have been provided by the UCLA Planetary Data System and include the magnetometer component measurements at specific times and a parallel set of position data relative to the planet center. Provision of the data in the requested Jupiter -centered coordinates with an x-axis as the sun-planet line by the Planetary data system renders it possible for the proposed project to be done in a reasonable amount of time using the relatively modest computational facilities available at USNA. The intent is to divide the data into subsets corresponding to time intervals associated with a particular magnetic axis position and to fit the data to chisquare expressions in such a way as to seek to minimize the total chisquare yielded by the 8 sets for the entire body of the data.

Collinear Multibeam Phase Conjugation in a Photorefractive Crystal

Researcher: Midshipman 1/C Michael P. Gallagher, USN
Adviser: Assistant Professor Steven R. Montgomery

When collinear laser beams that have extraordinary polarizations and different wavelengths, such as from an all lines argon ion laser, enter a photorefractive crystal a cone of light can be produced in the beam fan on the output side of the crystal that results in a series of multicolored rings when the cone illuminates a flat screen. If a beam comprised of a single laser line is incident upon the crystal with linear polarization consisting of equal components of extraordinary and ordinary polarization, a hyperbolic structure rather than a ring appears on the viewing screen. The aim of this project was to reflect the emerging multicolored cone back to a crystal of cerium doped barium strontium potassium sodium niobate (BSKNN) and produce phase conjugation in each of the colored

beams, as has been reported in the literature, and extend to the novel case where the single line beam has both polarizations to produce the phase conjugate signal for the ordinary beam. No phase conjugation was observed in the latter case most probably due to the fact that a large portion of the emerging light cone is incident upon the exit face of the crystal at an angle larger than the critical angle and thus does not emerge to be reflected back upon itself. A polished half cylinder shaped crystal would solve this problem and should allow the coupling between ordinary and extraordinary light to be observed.

Magnetic Resonance in a Superconducting Solenoid

Researchers: Midshipmen 1/C Michael T. Amos and Scott R. Seyfarth, USN

Adviser: Professor Donald J. Treacy

The aim of this program was to construct and operate a superconducting magnet to observe magnetic resonance at high magnetic fields. The superconducting solenoids and associated electronics were present in the Physics Department but they had to be put together and operated as a system. The system was constructed, integrated, and operated. Time precluded the regular operation of this system to detect magnetic resonance but it will be used for this purpose in the immediate future. A full set of operational parameters for this system was obtained.

Elemental and Isotopic Analysis of Meteorites

Researcher: Midshipman 1/C Matthew A. LaBonte, USN

Adviser: Assistant Professor Jeffrey R.Vanhoy

Chemical and accelerator-based elemental analysis techniques are used to determine the chemical composition of materials. The popularity of accelerator-based techniques such as PIXE (proton induced x-ray emission) is currently growing rapidly because the sample remains intact and undamaged. Both these techniques determine elemental and isotopic compositions of samples. We have analyzed the Allende meteorite, which fell in Chihuahua, Mexico on 8 February 1969. It is a CV type pockmarked by multiple chondrules and inclusions. PIGE (proton-induced gamma emission) can be used to identify isotopes with $Z < 30$. PIGE worked very well for identifying ^{23}Na, $^{24-26}Mg$, ^{27}Al, and $^{28-30}Si$ isotopes in the sample, but other elements of interest such as Ti require better statistics-- either more beam current or longer counting times.

Neutron activation is not constrained by the Coulomb barrier and is thus applicable of a wider range of elements. Unfortunately this method does not allow one to observe all the isotopes of a particular element A, but only those whose $A+1$ neighbor is radioactive. We defined a "Figure of Merit" to determine our sensitivity to various isotopes. One observes that a short counting experiment favors short-lived nuclei, and a long counting experiment favors those nuclei with large capture cross sections. After activating the sample overnight with an unmoderated ^{252}Cf source and three days of counting, only ^{23}Na was readily identified.

In the future we hope to try an inelastic neutron scattering technique. The accelerator lab cannot accommodate the shielding required for neutron scattering experiments. It may be possible to do these measurements with the 14 MeV neutron generator, but special care must be taken to limit the neutron-induced damage to the Germanium detector. Because all isotopes of a particular element have nearly the same optical model parameters, cross-sections are the same order of magnitude for neighboring nuclei. Hence, this technique remains promising for samples larger than ≈ 1 gram.

Publications

ALBERT, C. Flise, Associate Professor, co-author, "An Absorption Line Detection of the High Velocity Cloud Complex M," *Proceedings* of the Third Annual Astrophysics Conference: Back to the Galaxy, University of Maryland, College Park, Maryland, pp. 532-535.

The High Velocity Cloud Complex M has been detected in absorption toward the halo star BD +38 2182 with the International Ultraviolet Explorer Satellite echelle spectrograph. Absorption is seen out to -120 km/sec in the saturated resonance lines of C II, Si II, and O I. The absorption line detection toward BD +38 2182, along with the nondetection at velocities less than -100 km/sec toward the halo star HD 93521 which also lies in the direction of M II (27 arcminutes away from BD +38 2182) places the distance to Complex M at 1.5 to 4.1 kiloparsecs above the galactic plane.

BRILL, Donald W., Professor, "Approximate Descriptions of the Sound Fields Scattered by Insonofied, Submerged, Ribbed, Flat-ended Cylindrical Structures," *Journal of the Acoustical Society of America,* 93 (1) (January 1993), 71-79.

Backscattering of momochromatic plane sound waves from a soft cylinder of finite length and reinforced with N ribs are considered. The Kirchhoff and the Keller approximations are used in various different combinations to produce plots of the target strength (TS) versus incidence angle for purposes of comparison. The angular scattering patterns which result from the combination of methods used here agree fairly well away from the broadside incidence where the strongest differences appear. It is felt that some of the predictions of these combinations of methods represent good estimates for the numerical solution corresponding to an elastic shell with flat ends and N internal ribs.

CORRELL, Francis D., Professor, James R., HUDDLE, Associate Professor, Jeffrey R. VANHOY, Assistant Professor, William D. KULP, Charles A., McCARTNEY and Gerhard S. SCHOENTHAL, Midshipmen 1/C, USN, "Naval Academy Tandem Accelerator Laboratory (NATALY) Annual Report," *Proceedings* of the

Twenty-Fifth Symposium of North Eastern Accelerator Personnel, Singapore: World Scientific Publishing Company, 1992, pp. 380-381.

An upgrade to the Alphatross injector on our NEC 5SDH (1.7 MV) Pelletron was completed in July 1991. The new injector is an Alphatross/SNICS II twin injector, and uses many of the parts from the original injector. Typical 2 MeV proton beam currents measured in a shielded Faraday cup 84 cm down-beam of the analyzing magnet now exceed 1 μA. A Standard Operating Procedure (SOP) for our Pelletron has been written which meets Naval Academy and U.S. Navy Radiation Affairs Support Program (RASP) standards. Research in NATALY since our SNEAP '90 Report has used in-air PIXE for provenancing studies of Native American stone tools found in the Southern Maryland region. This work was done in collaboration with the Maryland Historical Trust, and made use of the home-built electrostatic quadrupole triplet lens described in our previous report. The researchers have also purchased a Princeton Gamma-Tech (PGT) Omega™ ultra-thin window Si(Li) detector for light-element, in-vacuum PIXE.

ENGLE, Irene M., Associate Professor, "The Field of the Jovian Magnetosphere, Including Contributions of the Magnetopause Surface Currents," *Journal of Geophysical Research,* 97, (August 1992) 17169-17172.

An idealized large-scale Jovian magnetospheric field has been computed by calculating the contribution due to the currents on the surface of the magnetopause (calculated from theory). This contribution is added to those of a model current system in the magnetic equatorial plane and the intrinsic dipole field of the planet. Convenient spherical harmonic representations of the field in the region inside the magnetopause have been developed. The Voyager observation model is compared with the Pioneer observation model.

ENGLE, Irene M., Associate Professor, "Diurnal Variation in Jovian Subsolar Magnetopause Position," Advanced Space Research, 12, (November 1992), (8)249-(8)255.

The calculation of the idealized Jovian magnetosphere surface and magnetic fields arising from surface currents has been published. [Engle, 1991] That calculation assumed the axis of all the interior sources of magnetic field to be perpendicular to the planet's orbital plane and hence to the incident solar wind. The rotation axis of Jupiter makes a small angle ([Picture]) with its orbital plane; the magnetic axis is aligned approximately [Picture] with respect to the planet's rotation axis. The consequences are that the magnetic axis will precess about the planetary rotation axis during each diurnal rotation of period $9^h 55^m$. The goal of the present work was to calculate the primary effects of this diurnal motion. In this paper are presented the results of calculations which have yielded global magnetopause models with the interior sources' axis tilted [Picture] (in the noon/midnight plane) with respect to the normal to the "plane" of the incident solar wind (which is here approximated to be coincident with the planet's equatorial plane). The consequential diurnally cyclical range in predicted dynamically stable magnetopause positions in the neighborhood of the subsolar point are reported. The magnetic fields arising from the magnetohydrodynamically stable currents on the magnetopause have been calculated. Convenient expressions for those fields' total contributions for points in the inner magnetosphere are included.

ENGLE, Irene M., Associate Professor, "Women Physicists: Observations on the Changing Milieu - Then and Now : Contemporary Vignettes," CSWP Gazette, 12 (October 1992), 3-8.

I recall being inspired by the Physics Today article by Professor Kistiakowsky "Women in Physics, Harmful, Injurious, Out of Place?" I feel honored to be asked to participate on the panel to explore the issues. When I learned who the other speakers at the panel session were to be, my first reaction was panic. Dr. Cladis and Professors Cooper and Kistiakowsky are all well-established in three of the venerated bastions of physics. As I thought about the questions that I was asking myself; "Where Are We?", "What is out Collective Goal?", What is Our Direction?", "How Fast Are We Moving?", I decided to address my presentation to some of the generally "unmentionable" social issues which (at least in the past) all too often contributed destructively to the climate in which women physicists strive to go about their business being

physicists.

FONTANELLA, John J., Professor, and Mary C. WINTERSGILL, Professor, "Dielectric Relaxations in Polyperfluoropropylene Oxide," *Macromolecules*, 25 (1992), 3815-3816.

Dielectric measurements were made on samples of perfluoropropylene oxide having molecular weights of 1850 and 8250 at frequencies from 10 to 10^5 Hz and temperatures from 5 to 295K. At 1 kHz, the glass transitions occurred at 213 and 252K respectively. In both materials there is a secondary relaxation near 100K which is very similar to one which has been observed in FEP and PFA fluorocarbon resins and is attributed to the onset of the motion of side groups.

FONTANELLA, J. J., Professor, and Mary C. WINTERSGILL, Professor, "UltralowTemperature Dielectric Relaxations in Polyolefins," *Macromolecules*, 25 (1992), 6871-6875.

Dielectric measurements were made on polyethylene, polypropylene, and a stabilizer, Irgonox 1010, down to and below the temperature of liquid helium. All three materials exhibited a relaxation in which the frequency is proportional to the absolute temperature with $f/T \approx 1$ kHz/K. This phenomenon is indicative of quantum mechanical tunneling with an activation enthalpy close to zero and a negative activation entropy. Alternatively, the relationship may be expressed in terms of a transmission coefficient of about 3×10^{-7}. There is evidence that the presence of a stabilizer such as Irgonox 1010 may be responsible for the ultralow temperature relaxation in the polymer samples.

TANKERSLEY, Lawrence L., Professor,.co-author, "Low-light-level, Quantum-noise-limited Amplification in a Stimulated Raman Amplifier," *JOSA B*, 9, 11 (November 1992), 2107.

We have investigated the noise characteristics and the low-light-level imaging capabilities of a stimulated Raman amplifier. Diffraction-limited Stokes beams as well as Stokes beams carrying spatial structure have been amplified using a collimated pump with a Fresnel number in the range 3 to 17. Both direct imaging and Fourier transform imaging of the Stokes signal through the

Raman amplifier were used. Results indicate that approximately 1 - 4 photons per spatial mode are needed to produce images with a signal-to-noise ratio of 1. Amplification of the Fourier transform of the object effectively provides a spatial filtering of the noise and gives the best signal-to-noise at the lowest input levels for our experiments.

TREACY, Donald J., Professor, co-authors, "^{31}P electron-nuclear double resonance of the P_{In} antisite in InP:Zn detected via luminescence,:" *Physical Review* 46, 1377 (1992), 1377.

Optically detected electron-nuclear double resonance (ODENDOR) has been observed via photoluminescence from the first neighbor ^{31}P shell of the phosphorus antisite in zinc-doped InP. Analysis of the ENDOR data confirms a tetrahedral arrangement of ^{31}P nuclei. The hyperfine interaction for each of these nuclei is axial with | $A_{||}$ | / h =368.0±0.5 MHz and | $A_{\perp}$ | / h =247.8±0.5 MHz. These parameters are slightly different from those reported by Jeon *et al.* [Phys. Rev. B 36, 1324 (1987)]. A shift of the ENDOR frequencies correlated with a change in the central nuclear-spin state has also been observed. We have been able to account for this shift with a perturbation treatment in which the electronic spin and central nuclear spin are treated exactly and a neighboring spin provides the perturbation. The best ENDOR signals are obtained with low optical-excitation-power density (0.1 W/cm^2) and low microwave modulation frequency (17Hz). These conditions emphasize the contributions to the optically detected magnetic-resonance signal from distant donor-acceptor pairs.

VANHOY, Jeffrey R. Assistant Professor, James R.HUDDLE, Associate Professor, F.David CORRELL, Professor; and William.D KULP, Gerald S. SCHOENTHAL and C. A. McCARTNEY, Midshipmen First Class; "NATALY Naval Academy Tandem Accelerator Laboratory SNEAP 1991 Report", *Procedings* of the Symposium of Northeastern Accelerator Personnel - 1991, eds. J. Benson, L. Rowton, J. Tesmer and R. Darling. Singapore: World Scientific, 1992, pp. 380.

This conference paper describes developments to the accelerator laboratory during 1991. Included are discussions on the SNICS injector upgrade,

energy resolution, and experience with the LabVIEW (National Instruments) control package.

WINTERSGILL, Mary C., and FONTANELLA, John J., Professors, "The Effect of Pressure on the Dielectric $^\gamma$-relaxation in Polytetrafluoroethylene and FEP," *Macromolecules*, 25 (1992), 7145-7149.

Dielectric measurements were made on PTFE at temperatures from 188 to 237K and pressures up to 3000 atmospheres. With increasing pressure, internal motions are restricted due to decreases in volume, and the $^\gamma$-relaxation shifts to higher temperatures and lower frequencies with an increasing Arrhenius activation energy. The activation volume decreases wih increasing pressure but is larger than for the analogous relaxation in polyethylene. The distribution of Helmholtz activation free energies is independent of pressure. In FEP, the copolymer of tetrafluoroethylene and hexafluoropropylene, the loss peak is thought to be a composite of the $^\gamma$ and β-relaxations.

WINTERSGILL, Mary C., Professor, John J. FONTANELLA, Professor, and Michael G. MCLIN, ONT Postdoctoral Fellow, "High Pressure Studies of Hydrated NAFION Membranes: Dielectric Relaxation and Deuteron NMR," *Solid State Ionics*, 60 (1993), 137-140.

Audio frequency electrical conductivity/dielectric relaxation and nuclear magnetic resonance studies of Nafion-117 have been carried out at pressures up to 0.3 GPa (3 kbar). For some samples, the electrical conductivity exhibits dispersion typical of hopping conductivity in an amorphous material, $\sigma = \sigma_0 \omega^m$. The values of m are sample dependent and vary from about 0.55 to 0.75. In addition, the values of m are not strongly pressure sensitive. At a given frequency, the electrical conductivity tends to decrease as pressure increases and yield activation volumes on the order of 5 to 10 cm^3/mol. The activation volume determined from the NMR spin-lattice relaxation time measurements are also sample dependent. The data shown correspond to an activation volume of about 8.6 cm^3/mol.

WINTERSGILL, Mary C., and John J. FONTANELLA, Professors, "Effect of H$_2$O on Dielectric Properties of Berlinite: II. Dielectric Loss" *Journal of Physics D: Applied Physics*, 26

(1993), 101-105.

Audio frequency complex impedance measurements have been carried out over the temperature range 5.5 - 380 K on samples of berlinite (aluminum phosphate) both parallel and perpendicular to the optic axis. The berlinite samples contain varying amounts of water. All of the berlinite samples exhibit a dielectric relaxation peak in the vicinity of 40K and 1000 Hz. The data were best-fit using an expression based on the stretched exponential, SE. The best-fit SE parameter, β_{SE}, ranges from 0.68 to 0.85. In the direction perpendicular to the optic axis, the activation energy is approximately 0.053 eV and the relaxation is correlated with the acqueous solution inside inclusions. The relaxation parallel to the optic axis has an activation energy of about 0.049 eV and is attributed to hydroxyl ions at the surface of the inclusions. A dielectric relaxation peak is also observed near 240K and 1000 Hz for the samples with higher nominal water concentration. In addition, dielectric loss, which is attributed to trace impurities or Maxwell Wagner polarization of inclusions, is observed in the vicinity of room temperature.

Presentations

ALBERT, C. Elise., Associate Professor, "Interstellar Gas in the Galactic Halo," Laboratory for Astronomy and Solar Physics, Goddard Spaceflight Center, Greenbelt, Maryland, 17 December 1992.

ALBERT, C. Elise., Associate Professor, "A High Resolution Optical and Radio Study of Milky Way Halo Gas," The American Astronomical Society, Phoenix Arizona, 6 January 1993.

ALBERT, C. Elise., Associate Professor, "Interstellar Gas in the Galactic Halo," U.S. Naval Academy, Physics Department Scholarly Activities Colloquium, Annapolis, Maryland, 9 Feburary 1993.

CALAME, Gerald P., Professor "Life Outside the Solar System," USNA chapter of the Society Of Physics Students, Annapolis, Maryland, 22 March 1993.

CORRELL, Francis D., Professor, co-author, "Elemental Analysis of MOR Hydrothermal Metalliferous Sulfide Deposits by PIXE," Western Pacific Geophysics Meeting of the American Geophysical Union, Hong Kong, 18 August 1992.

CORRELL, Francis D., Professor, co-author, "PIXE in Archaeology and Geology: Stone Tools and Hydrothermal Vent Smoke," Twelfth International Conference on the Application of Accelerators in Research and Industry, Denton, Texas, 3 November 1992.

CORRELL, Francis D., Professor, co-author, "Estuarine Biofiltration: Trace Metals in the Livers of the Oyster Toadfish (*Opsanus Tau*)," 1993 Spring Meeting of the American Geophysical Union, Baltimore, Maryland, 26 May 1993.

CORRELL, Francis D., Professor, co-author, "Ocean Floor Weathering: Elemental Changes with Depth as Determined by PIXE," 1993 Spring Meeting of the American Geophysical Union, Baltimore Maryland, 27 May 1993.

ELDER, Samuel A., Professor, "Root Locus Equations for the Vibrating Diaphragm Model of Jet-Pipe Action," 125th Meeting of the Acoustical Society of America, Ottawa Ontario Canada, 20 May 1993.

ENGLE, Irene M., Associate Professor, "Some Visions of the Global Jovian Magnetospheric Field", Goertz-Smith Memorial Symposium "Magnetospheres of the Outer Planets," University of California, Los Angeles, California, 24 June 1992.

ERTEL, John P., Associate Professor, "Interactive Physics II," AAPT-CIPE (the committee on Computers In Physics Education), Summer Meeting of the American Association of Physics Teachers, Orono, Maine, 8-15 August 1992.

ERTEL, John P., Associate Professor, "Interactive Physics II & Beyond," AAPT-CIPE (the Committee on Computers in Physics Education) Winter Meeting of the American Association of Physics

Teachers , New Orleans, Louisiana, 1-8 January 1993.

ERTEL, John P., Associate Professor, "Interactive Physics II & Beyond," Physics Department, South Carolina State University, Orangeberg, South Carolina, 13 February 1993.

HUDDLE, James R., Associate Professor, "Let's Observe Tonight's Lunar Eclipse!," John Downs Park, Pasadena, Maryland, 14-15 June 1992.

HUDDLE, James R., Associate Professor, "Images of the Great Total Solar Eclipse of 1991," American Association of Physics Teachers Summer Meeting, Orono, Maine, 10-15 August 1992.

HUDDLE, James R., Associate Professor, and C. Elise ALBERT, Associate Professor, "Tour of The Class of '41 Alvan Clark Telescope and Observatory," Maryland Space Grant Conference, U.S. Naval Academy, Annapolis, Maryland, 2 October 1992.

HUDDLE, James R., Associate Professor, "Teaching Undergraduate Physics With a Small Tandem Accelerator: Moseley's Law," 12th International Conference on the Application of Accelerators in Research & Industry, Workshop on Teaching with Accelerators, Denton, Texas, 31 October - 5 November 1992.

HUDDLE, James R., Associate Professor, "MOON '92: A Lunometry Project," U.S. Naval Academy, Physics Department Scholarly Activities Colloquium, Annapolis, Maryland, 2 December 1992.

HUDDLE, James R., Associate Professor, Francis D. CORRELL, Professor, and Douglas W. EDSALL, Professor, (Oceanography), "Elemental Analysis of MOR Hydrothermal Metalliferous Sulfide Deposits by PIXE," American Geophysical Union Western Geophysics Meeting, Hong Kong, 17-21 August 1992.

MONTGOMERY, Steven R., Assistant Professor, Michael D. MATSON, Midshipman 1/C, USN, "Holographic Interferometry on an Acoustic Guitar," Eastern Colleges Science Conference, U.S. Naval Academy, Annapolis, Maryland, 4 April 1992.

MONTGOMERY, Steven R., Assistant Professor, Charles A. MCCARTNEY, Midshipman 1/C, USN, "Picosecond Optical Mixing in Photorefractive

Materials," Eastern Colleges Science Conference, U.S. Naval Academy, Annapolis, Maryland, 4 April 1992.

MOSCA, Eugene P,. Associate Professor, "Implications of Teaching Electrical Circuits Using a Compressible-Fluid Model of Charge Conduction," Winter Meeting of the American Association of Physics Teachers, New Orleans, Louisiana, 1-8 January 1993.

TANKERSLEY, Lawrence L., Professor, "Time-Gated Imaging in Thick Tissues using Stimulated Raman Scattering," Conference on Lasers and Electrooptics '93, Baltimore, Maryland, 3-7 May 1993.

VANHOY, Jeffrey R., Assistant Professor, "Collective Excitations Evinced by Fast Dipole Transitions," Meeting of the 6th International Conference on Nuclei Far from Stability and 9th International Conference on Atomic Massses and Fundamental Constants, Bernkastel-Kues Germany, 19-24 July 1992.

VANHOY, Jeffrey R., Assistant Professor, "Measurement of B(M1) Strength for 1+ Mixed Symmetry States in 162,164Dy by Inelastic Neutron Scattering," American Chemical Society Meeting, Washington, DC, 23-28 August 1992.

VANHOY, Jeffrey R., Assistant Professor, John M. ANTHONY, Assistant Professor, "Transition Rates in 142Ce from Inelastic Neutron Scattering," Sante Fe, New Mexico, 14-17 October 1992.

VANHOY, Jeffrey R., Assistant Professor, co-author, "Lifetimes and Electromagnetic Decay Proerties of 1+ Mixed-Symmetry States in 162,164Dy," Sante Fe, New Mexico, 14-17 October 1992.

WINTERSGILL, Mary C., Professor, John J. FONTANELLA, Professor, and Michael G. MCLIN, ONT Postdoctoral Fellow, "High Pressure Studies of Hydrated NAFION Membranes: Dielectric Relaxation and Deuteron NMR," Polymer Ionics, Gothenburg, Sweden, 19-21 August 1992.

WINTERSGILL, Mary C., Professor, John J. FONTANELLA, Professor, and Michael G. MCLIN, ONT Postdoctoral Fellow, "High Pressure Deuteron and Oxygen-17 NMR and Electrical Relaxation Studies of Hydrated NAFION

Membranes," The Electrochemical Society, Honolulu, Hawaii, 16-21 May 1993.

WINTERSGILL, Mary C., Professor, John J. FONTANELLA, Professor, and Michael G.

MCLIN, ONT Postdoctoral Fellow, "Electric Modulus and ^{7}Li NMR Studies of Poly(propylene oxide) complexed with $LiClO_4$, $LiAsF_6$ and $LiN(CF_3SO_3)_2$," The Electrochemical Society, Honolulu, Hawaii, 16-21 May 1993.

Division of
Professional Development

Leadership and Law

Commander Robert A. Gurczynski, USN
Chair

Members of the Department of Leadership and Law continued research aimed at improving and affecting midshipmen behavior and their subsequent performance in the active Naval Service. Research accomplished during the 1992-1993 academic year included: Dr. Karel Montor's development of an ethics book for junior officers and development of new techniques for computer aided teaching and Dr. Roush's further refinement of MBTI analysis related to midshipman and officer performance. The publications and presentations of the staff have further expanded the department's role in leading the Naval Service in matters dealing with leadership instruction and development and represent our commitment to providing every midshipman a Total Quality Education.

Independent Research

Video Development

Researcher: Professor Karel Montor and Midshipmen

A specialized research program, begun during AY 1991-1992, to identify appropriate classroom visual materials for use by instructors, was completed. Over 150 full length films have been recorded off the air or purchased, and half of them have had subject matter digests prepared These films, to be used individually, permit teachers to present leadership concepts to students in the visual mode that they have become accustomed to, prior to arriving at Annapolis. In addition, film clips have been prepared that illustrate various leadership principles and concepts.

Ethics for the Junior Officer

Researcher: Professor Karel Montor and Division of Professional Development Faculty

Within the Leadership and Law Department, and commissioned by the USNA Class of 1964, a volume on Military Ethics is being prepared for issue to all midshipmen prior to their graduation. This book will be issued each and every year to future classes starting with the Class of 1994. Cases involving ethics decisions, that actually happened in all branches of the Armed Forces, have been collected. Visits to several military sites were conducted and after write-up of the case by the principal researcher they are reviewed by a team that represents various branches and services of the military. A novel method of presentation has been developed which will guide the reader through ethical considerations and interfere with the immediate determination of what happened and thus minimize a misinterpretation of the ethical point being enunciated.

Computer Aided Teaching

Researcher: Professor Karel Montor

As USNA utilizes a two-hour course leadership format the economical employment of leadership instructors dictates that they each teach approximately 100 midshipmen, or roughly a doubling of assigned students per instructor starting in the Fall of 1993. To prepare for mechanics changes that might be required for this undertaking, 111 students were taught by the researcher. Interest in the subject and students was easily maintained but ability to individually communicate with so many was lost until an E-Mail system was set up at home which allowed all students from their rooms, without having to go the phone, to communicate day and night with the professor. It also permitted the instructor to send individual notes each evening to various students complementing them on their performance and/or raising questions about their thoughts expressed in class. In this way, a midshipman might raise a question about 7 P.M., have it answered at 8 P.M., be able to ask a follow-on question at 10 P.M. and have it answered at 11 P.M. It was found that roughly 90% of all questions could be answered in this fashion with the other 10% handled through an appointment during the next day or invited to call the researcher that night at home. Excellent communication was achieved between midshipmen and instructor.

Applications of Psychological Preferences in the Military

Researcher: Associate Professor Paul E. Roush

This is a continuation of a research project begun in July 1987. Purpose of the research is to assess how knowledge of psychological preferences can be used in the military in the many manifestations of "know yourself, know your people, know your job." The primary research instrument is the Myers-Briggs Type Indicator (MBTI). The effort thus far has resulted in more than thirteen thousand administrations of the instrument and development in conjunction with computer services of five computer programs for scoring the MBTI, accessing the data, and linking it to a wide range of variables. The study has included analysis of MBTI associations with leadership feedback, counseling feedback, transformational and transactional leadership, academic performance, voluntary attrition, time management, preference stability over time, service selection, leadership positions in the brigade, conduct grades, military performance grades, and accuracy of self-assessment. It has resulted to date in six presentations; three at regional conferences and one at an international conference of the Association for Psychological Type, one at the institutional research conference of the service academies, and one at the bi-annual leadership conference of the Center for Creative Leadership. Thus far, the project has resulted in the publication of articles in the *Journal of Psychological Type*, *Military Psychology*, and a chapter in an edited book, *The Impact of Leadership*. Leadership curricula and materials have been modified for the inclusion of MBTI theory and practice into two leadership courses taken by all midshipmen to increase their understanding of the meaning and importance of individual differences. For the first time in Academic year 1992-1993 midshipmen 3/C completed an expanded version of the MBTI, the Expanded Analysis Report (EAR), and received the interpretation during the new 3/C leadership course, NL202: Developing Subordinates. To date, presentations have been made locally to the faculties of three departments, English, Language Studies, and History in order to acquaint those faculty members with the use of the MBTI to account for differing learning styles as a function of type differences. Local programming support for the MBTI research project is provided by Julie Palmer in Computer Services.

Enhanced Leadership Development

Researcher: Associate Professor Paul E. Roush

This project began in September 1987. Phase One of the research project involved development of NL301, a summer leadership course taken by all midshipmen. The course required each second classman to subject the plebe development program to a more rigorous and systematic scrutiny than had been the case prior to NL301. The course injected planning into that process and served as a rational counterpoise to the traditional approach of simply requiring new plebes to repeat upperclassmen's plebe experiences. In another aspect of NL301, class sessions were set aside for analysis by the midshipmen of very difficult problems facing the brigade. Midshipmen recommended solutions which, in turn, were screened, compiled, and forwarded for consideration by the Commandant. Phase Two of the project involved development of linkages between the classroom leadership work and the practical leadership experience in Bancroft Hall. Initially, that involved writing-projects which provided valuable feedback concerning the leadership experiences, from both the leaders' and the followers' perspectives. During academic year 1990-1991 the process was further expanded. The plebes used their personal computers to respond anonymously on three occasions to questions dealing with the leadership practices of the second classmen in their respective squads. On two occasions, after the upperclass had assessed themselves using the same criteria, the ratings supplied by the plebes were provided to the upperclass (in the form of aggregated data) as constructive feedback, during the second class leadership course in the spring semester. The feedback was the catalyst for significant changes in leadership behavior and in self-perception among many of the second classmen. This phase of the project yielded linkages between leadership feedback and the MBTI, and was the basis for two presentations in July 1991, one at the International Conference of the Association for Psychological Type and the second at the bi-annual research conference of the Center For Creative Leadership. Phase Three involved having the second classmen in one of the six battalions receive different leadership instruction from that provided all the other battalions in the Spring 1991 semester. The special instruction emphasized a particular counseling approach, and required significant documentation of the counseling process as part of the course work. The second classmen involved were rated by the plebes as making significantly greater improvement in positive leadership practices than were the second classmen in the other battalions. That counseling program was instituted brigade-wide beginning in the 1991-1992 academic year. The leadership feedback program provided objective evidence that the fourth class perceived upperclass leadership in 1991-1992 as being more positive in all thirty-two categories than was the case a year earlier. In academic year 1992-1993 the positive trend continued. The leadership behavior of the second class moved further in the direction of the thirty-two criteria than had been the case with their two predecessor classes. The evidence that behavior changes in the direction of evaluative criteria is very strong. The next phase of the project will have all three underclasses evaluating the leadership behaviors of the first-class squad leaders as soon as programming resources can be allocated. Local programming support for the Leadership Feedback project was originally provided by then Lieutenant Blake Bush, USN, of the Professional Development Division. In an expanded version, the programming support is now under the auspices of Julie Palmer of Computer Services.

Performance of USNA Graduates

Researcher: Associate Professor Paul E. Roush

This research program was accomplished in conjunction with the Naval Personnel Research and Development Center (NPRDC). During academic year 1990-1991 nearly two million fitness reports in the NPRDC database were analyzed at San Diego. The fitness reports encompassed a span of eighteen years (1972-1990) and all officer accession sources. The indicators of performance included continuation

rates (a measure of willingness to remain on active duty), and rate of recommendation for early promotion. Outcomes to date include comparison of performance of Naval Academy graduates with that of officers from other accession sources, comparison among academy graduates by gender and by majority-minority status, and comparison of women graduates and minority graduates with women and minority officers from other accession sources. Marine Corps fitness-report data have been acquired from Headquarters, Marine Corps, and were analyzed at NPRDC. Initial review of more than a million of these USMC fitness reports has now been concluded. Comparative results by accession source and by occupational specialty have

been compiled for five indices on the fitness report. A separate breakout of results before and after 1980, the year the first women graduated from USNA, was also compiled. Fitness report data were sorted by rank and separated out for the years 1966-1972 to assess potential differences in performance during the Viet Nam conflict. In addition, the Graduate Performance Evaluation System (GRAPES) questionnaire was substantially revised and piloted on a small sample in San Diego. The new version was mailed to the fleet and the returns have been analyzed at NPRDC although the final report is not yet available. The project has been transferred to the auspices of the Office of Institutional Research at USNA.

Use of Time by Midshipmen

Researcher: Associate Professor Paul E. Roush

This research project, ongoing on a twice-a-year basis since 1990, is an expanded version of one conducted in 1989 by Dr. Montor. The project involves stratified-random sampling of approximately a fourth of the brigade in the fall semester and again in the spring semester to survey time use by the members of the brigade. Midshipmen respond, using their personal computers, by distributing into 34 categories the 168 hours that constitute a week. The results are analyzed in order to assemble evidence regarding potential initiatives and to assess the effectiveness of

previous initiatives intended, for example, to put limits on certain activities and to maximize time available for study. Data are analyzed to ascertain time-use differentials by classes, by athletes versus non-athletes, by gender, QPR, major, service selection and other variables. Local programming support for the Leadership Feedback project was originally provided by then Lieutenant Blake Bush, USN, of the Professional Development Division. In an expanded version, the programming support is now under the auspices of Julie Palmer of Computer Services.

Midshipmen Values Assessment

Researcher: Associate Professor Paul E. Roush

This research project involves having midshipmen respond on a survey about the values they hold. The survey began with the class of 1995. It is done upon entry during the first week of plebe summer, upon completion of plebe summer, at the end of plebe year, midway through 3/C year at the end of 2/C year and prior to graduation during 1/C year. The values survey was developed by the Institutional Research Office at West Point and has been in use there for more than a decade. The results of the survey administrations will enable us to assess the

effectiveness of values inculcation during plebe summer and all of plebe year. In addition, we should be able to track the maturation of values as midshipmen progress through the four-year curriculum. Another potentially rich area for research currently underway is correlational studies in which values are linked with a series of other variables. Finally, survey results will be compared with those at West Point to ascertain if changes follow the same pattern (are comparable in magnitude and direction) at both institutions.

Publications

ROUSH, Paul E., Associate Professor, "The Myers-Briggs Type Indicator, Subordinate Feedback, and Perceptions of Leadership Effectiveness," eds. Clark, K.E., Clark, M.B., and Campbell, D.P. *Impact of Leadership*. Greensboro, North Carolina: The Center for Creative Leadership, 1992, pp. 529-544.

Results of this study indicate that ratings of leader effectiveness varied with the leader's and rater's psychological preferences as inferred from the Myers-Briggs Type Indicator. *Self-ratings of leaders differed significantly from ratings provided by followers.* When feedback regarding follower perceptions of leader effectiveness was provided to leaders under the conditions reported in the study, the leaders altered their behavior and modified their self-perceptions of effectiveness.

Presentations

BARRY, James, Assistant Professor, "Myers-Briggs Typing in Relation to Motivation," The Quebec Nordiques, NHL Hockey Team, U.S. Naval Academy, Annapolis, Maryland, 18 February 1993.

MONTOR, Karel, Professor, "Dealing with Personnel Who are Not Living up to Their Potential," Forty-five Northeast District Managers of Dean Witter Reynolds, Annapolis, Maryland, 22 April 1993.

ROUSH, Paul E., Associate Professor, "The Influence of Upward Feedback on Self- and Followers' Ratings of Leadership," Society for Industrial and Organizational Psychology, San Francisco, California, (Joint presentation with Leanne Atwater and Allison Fischthal of State University of New York at Binghamton) 1 May 1993.

ROUSH, Paul E., Associate Professor, "Tailhook: Aberrant Behavior or Navy Culture?" Joint Services Conference of Professional Ethics, Washington, DC, 29 January 1993.

ROUSH, Paul E., Associate Professor, "Women and Cohesion in the Navy: Success or Failure Starts at the Top," Women Officers' Professional Association, Washington, DC, 8 July 1992.

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This annual report summarizes the research work of the Naval Academy faculty and midshipmen for the period July 1992 through June 1993. Sponsored and independent research projects are listed by title, followed by the names of the investigators and an abstract. A list of publications and their abstracts are included as well as presentations at professional meetings, conferences, and seminars.

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